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IMPROVEMENT STUDY

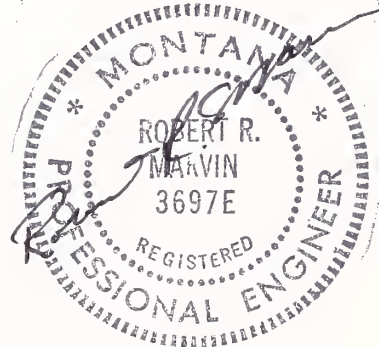
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YELLOWSTONE COUNTY
TRAFFIC SAFETY IMPROVEMENT
STUDY

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SEPTEMBER 1988



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INTRODUCTION

STUDY PURPOSE

Yellowstone County, in an effort to reduce or otherwise alleviate problems at accident cluster sites on the County Road System, has retained the Consulting Engineering Firm of Marvin & Associates to perform a traffic engineering study. The purpose of this study is to identify accident cluster locations, collect and analyze pertinent data, make short and long term safety improvement recommendations and establish a priority list of improvement projects.

This is the third such study completed in Yellowstone County. The first study, DCA Project No. 79-04-01-01, was completed approximately eight years ago and was the first such study within the State of Montana. The second study was completed in 1985 by Marvin & Associates. All of these studies have been completed with technical and organizational assistance of the Department of Justice, Highway Traffic Safety Division.

This report includes a section on 1985 Study Implementation Results. The site selection procedures indicated that accident cluster locations were being found at previous study sites. Seven of the 1985 study sites were included in the prioritization of improvement projects. Specific details of these sites are reference to the 1985 report, "Yellowstone County Traffic Safety Study".

The study methodology, which primarily served as the basis for the analysis within this report, can be found in the report No.FHWA-RD-77-83 "Identification of Hazardous Locations". Refinements to the FHWA report made by DCA Project No. 79-04-01-01 and subsequent county studies throughout the state, are also incorporated within this

report. The methodology used to establish priority rankings is explained in the Benefit/Cost Ratio section of this report and is tailored specifically to Yellowstone County's unique requirements.

The analysis of site data and hazard ranking was performed on a micro computer. Lotus 123 software was used to develop templates that are available for future use in establishing priority improvement project lists and will greatly aid in program continuation.

REPORT ORGANIZATION

Site specific data can be found within the site sections of this report. A great deal of computer generated data was printed and reduced for inclusion on the existing condition and short term improvement sketches. The availability of pertinent data on the same page as the sketches hopefully aids in comprehension of the problem identification and improvement benefits.

Specific information with regard to the 1985 Study Sites are not presented within this report other than information in the hazard index tables, benefit/cost calculation and figures at the end of this section.

The site specific sections of this report are numbered according to there priority ranking as indicated in the site location section of this report. Only 15 new sites were included in this project. Other sites included in the priority ranking, are 1985 study sites which are not numbered and do not have specific sections dedicated to each individual site. However, these sites are included in the recommended improvement program listing.

The basic organizational format of the site specific sections is as follows:

Narratives * Location Description

* Existing Conditions

Geometrics

Traffic Control Devices

Traffic Volumes

Traffic Operations

Accidents

* Short Term Improvements

* Long Term Improvements

* Benefits

Figures ~ Photos

~ Existing Condition Sketch

~ Short Term Improvement Sketch

1985 STUDY IMPLEMENTATION RESULTS

Twenty sites were studied in the 1985 Traffic Safety Study. These sites were primarily selected by Yellowstone County as they were areas of concern. Various levels of improvements were recommended at these sites. The majority of sites had conditions which required physical changes to the roadways or intersections. The average, expected reduction in accidents projected for these improvements was approximately 55% with an average benefit/cost ratio being approximately 5.8.

All of the 1985 study sites were inventoried in conjunction with the current study. It was found that Yellowstone County had completed all of the signing work, required by the recommended improvements, wherever possible. However, very little of the other elements of the improvements were implemented. All Yellowstone County roads were striped within the past two years, but the pavement marking changes were not always made as recommended.

Table 1. is a summary of the inventory and accident trends at the 1985 study sites. It is assumed that none of the signing changes were made prior to 1986, but it is difficult to tell exactly when any of the changes were implemented. It was assumed, for purposes of comparison, that the accident data in 1986 and 1987 reflects conditions after signing changes were made.

Table 1. lists the degree of improvements made at each site; the number of accidents in both the before (1981 to 1985) phase and the after (1986 & 1987); and the relative increase or decrease in accidents. There were only three sites that showed an increase in the average number of accidents. At all three of these sites, one or more

elements of the plan were not completed, so it is very difficult to determine what contributed to the increase. Similarly, some of the sites had reduced accident experience when none of the recommendations were implemented.

Overall, this data indicates a 48% reduction in accidents. Without an intensive study of traffic volume and accident trends throughout the county, it would be difficult to state that the improvements were the sole cause of accident reduction. However, we can be fairly certain that a large portion of the 48% reduction was due to the signing improvements.

TABLE 1. 1985 STUDY SITES & ACCIDENT TRENDS

SITE RANK	INTERSECTION OR MAJOR ROUTE	NO. ACC. 1981- 1985 TO 1985	NO. ACC. 1986 & 1987 AVG.	% DECRSE	% INCRSE	IMPROVES. MADE
1	GRAND AVENUE 54TH STREET W.	16	3.2	2	1	69% 100% EXCEPT STRIPING
2	SHEPHERD ROAD CHICAGO ROAD	12	2.4	3	1.5	38% 50% OF PLAN
3	OLD HIGHWAY 10 GOLF COURSE RD	10	2	1	0.5	75% 80% OF PLAN
4	OLD HARDIN ROAD BECRAFT LANE	21	4.2	4	2	52% 100% SIGN & JOHSON LN RECON.
5	12 MILE ROAD HOMER DAVIS ROAD	5	1	3	1.5	50% 100% EXCEPT STRIPING
6	OLD HARDIN ROAD PICCOLO LANE	14	2.8	1	0.5	82% 100% EXCEPT STRIP & CHANNEL
7	HIGHWAY 312 SHEPHERD ROAD	14	2.8	4	2	29% 10% OF PLAN
8	SHEPHERD ROAD SHEPHERD-ACTON RD	20	4	4	2	50% 100% EXCEPT STRIP & PHYSICAL
9	OLD HARDIN RD DICKIE RD.	8	1.6	0	0	100% 100% SIGNING, NO PHYSICAL IMPS.
10	NEIBAVER ROAD W. OF SHILO	5	1	5	2.5	150% 100% SIGNING, NO PHYSICAL IMPS.
11	JELLISON ROAD CURVES	12	2.4	5	2.5	4% 100% EXCEPT DELINEATORS
12	DOVER ROAD PIONEER ROAD	6	1.2	1	0.5	58% 20% OF PLAN
13	HIGHWAY 312 DOVER ROAD	24	4.8	5	2.5	48% 0% OF PLAN
14	HIGHWAY 312 MCGIRL ROAD	20	4	4	2	50% 0% OF PLAN
15	DANFORD ROAD 56TH STREET WEST	6	1.2	2	1	17% 100% EXCEPT STRIPING
16	HIGHWAY 312 BARRY ROAD	12	2.4	1	0.5	79% 0% OF PLAN
17	ROSEBUD LANE COBURN ROAD	10	2	1	0.5	75% 100% EXCEPT STRIP & PHYSICAL
18	HIGHWAY 312 DRURY LANE	9	1.8	3	1.5	17% 0% OF PLAN
19	HIGHWAY 312 HUNTLEY TURNOUT	9	1.8	2	1	44% 0% OF PLAN
20	KING AVE. WEST S. 32ND STREET W.*	36	6	2	2	67% 100% OF PLAN
TOTALS =		269		53		
AVERAGES =		13.5	2.6	2.7	1.4	48%

SITE CHARACTERISTICS

SITE LOCATIONS

The maps contained at the end of this section (Figures 1.) show the fifteen new sites respective to their priority numbers. Table 2. is a listing of site numbers corresponding to the site locations:

TABLE 2. LIST OF STUDY SITES

~~~~~

- 1 CENTRAL AVENUE & 56TH STREET W.
- 2 BENCH BLVD. & TWO MOON PARK
- 3 CA ROAD N. OF SCANDIA ROAD
- 4 INDIAN CAVES ROAD
- 5 DRURY LANE & HOSKINS ROAD
- 6 72ND STREET W. & LAUREL AIRPORT RD
- 7 OLD BLUE CREEK ROAD
- 8 NEIBAUER ROAD & 48TH STREET W.
- 9 72ND STREET W. AT R.R. TRACKS
- 10 BLUE CREEK ROAD & PRYOR ROAD
- 11 GARDEN AVE. N. OF SUGAR AVE.
- 12 VALLEY DRIVE NEAR COVE DITCH
- 13 NEIBAUER ROAD & 64TH STREET W.
- 14 OLD HARDIN ROAD & CLAYTON
- 15 ROAD 15N NORTH OF HWY 312

~~~~~


SYSTEM CHARACTERISTICS

Unlike the 1985 study, only four of the accident sites are in an urban environment. The majority of new study sites are on low volume, rural roads. This situation would be expected since cluster sites on low volume roads have a higher accident rate; speeds are higher and thus severity is usually greater; and the cost of making significant improvements is usually less. Since the site selection process for this study was based on statistical indicators, the low volume rural roads ranked high. Site selection for the 1985 study was based solely on number of accidents and local input.

These rural sites are all similar in geometric features and in the magnitude of traffic control device application. It is gratifying to observe that most of the sites, along with most of Yellowstone County's road system have at least a minimum degree of signing and pavement markings. The existing signing is, for the most part, consistent in application and well maintained.

The major problem observed at the new sites was again, the placement of signs. In particular, warning signs and stop signs were located at inappropriate locations. The advanced intersection and stop ahead signs are all located within 500 feet of the intersection. While MUTCD provides for advance warning signs to be located at various distances dependent upon speeds, engineering judgement is the overriding factor. In most cases, the shorter distance makes the sign ineffective, and sometimes blocks clear vision of the stop sign. Because of this, improvement recommendations within this report call for the relocation of warning signs.

In addition, it was determined that expectancy was a problem at most rural intersections. Because most intersections have a similar

appearance and motorists are not provided sufficient information regarding the identity of an intersecting road, inadequate reaction time is provided. To improve this situation, most of the recommendations require a supplementary street name sign to be added to advanced warning signs as provided in section 2D-39 of the MUTCD. This method seems to work very well. A 54% reduction in accident at intersections with this sign assembly was noted for the 1985 sites. This is greater than the average reduction for all of the sites.

Since consistency of signing is extremely important, Yellowstone County should plan on revising the applications and locations of signs on all county roads when these improvements are implemented. Standard signing applied consistently will aid in the elimination of accidents county wide.

The accident reports combined with field observation indicate that there may also be a problem with maintenance on some sections of roads. Pavement markings at most locations were infinitely better than during the 1985 study. The county should review the striping plans more carefully and insure that proper changes are made when the lines are striped again.

Some areas, where the predominant accident is occurring on icy or snow packed roads, require more vigilance during winter maintenance conditions. It is realized that the county has many miles of roadway to clear during the winter, but high accident sites should be given an extra degree of attention. Several of the locations had significant numbers of accidents clustered around a small period of time when icy conditions were prevalent. This may indicate that once the snow is removed, repeat visits to sand and/or salt the intersections or roadway sections are lacking.

FUTURE IMPROVEMENTS

Two general areas where the accident cluster sites were located during the site selection process should be of concern to Yellowstone County and should be given increased attention by the Planning Board.

Old Hardin Road - had taken the brunt of continually steady subdivision growth within the last 10 years. Traffic volumes ranging from 13,000 ADT near I-90 to 4,800 ADT near Johnson Lane had stressed the safety and capacity of the narrow roadway. Continuous roadside development between those two points have virtually no access control and thus capacity of the road is limited. To make matters worse, there has been a notable deterioration in the roadway surface.

The one salvation for Old Hardin Road has been the construction of the new I-90 Interchange at Johnson Lane. Its existence has reduced traffic volumes on Old Hardin Road dramatically. That project has forestalled any major reconstruction of Old Hardin Road. However accidents will continue to be a problem unless the entire stretch of roadway has traffic control and access modifications made.

Highway 312 - was previously the main highway east of Billings. When the interstate system east of Billings was completed the road reverted to localized access. As with most roads of this nature, the state Department of Highways transferred control of the road to local governments. Because these type of roads are usually old, maintenance responsibility is not readily accepted by the local governments primarily due to funding restrictions. This is the case with Highway 312.

Highway 312 extends from its western terminus at the Roundup turnoff in the Billings Heights to a point approximately 30 miles east at the Pompeys Pillar I-94 Interchange. It is a 26 foot wide two lane

roadway with outdated roadside design standards. Traffic volumes range from 7,600 ADT near the Roundup Turnoff to 2,200 ADT near Huntley.

Continued, steady residential development has occurred along its length in the past 10 to 15 years. The largest areas of growth have occurred within the first mile of Billings and within the Shepherd area. This growth has naturally increased traffic on Highway 312 which in turn is spawning roadside business developments. Several night club type establishments have located along the highway within the recent past and there is evidence of other future commercial concerns locating along the road.

While not at design capacity along most of its length at present, increased traffic volumes combined with additional roadside access has stressed the level of service on Highway 312 between Billings and Shepherd. The new accident data compiled for this study indicates a net reduction in accidents at the previous study sites. Traffic volumes have remained relatively stagnant over the past three years. However, new cluster sites along Highway 312 have occurred at other locations. It is difficult to determine whether accidents have been dropping or whether they have just moved.

This study addresses individual cluster sites but the county should recognize that there is a generalized problem along Highway 312 and that traffic control device installation must be consistent along its length. Virtually none of the 1985 recommended improvements were made on Highway 312. At some point, improvements will have to be made. If the local economy should improve, this section of roadway may have a safety problem of very large proportions.

STUDY METHODOLOGY

The study was segregated into four distinct phases which best achieved the purpose and scope of the traffic study. These phases are outlined as follows:

Phase 1 - Site Selection Phase; was involved copying all of the accident reports on Yellowstone County roads for the years 1984 thru 1987 from Department of Justice files in Helena, Montana. These reports were first arranged alphabetically and separated according to road names. Reports on each individual road were screened for location by intersecting roadway and cross referenced. Finally, the reports were separated by proximity of location. All identified clusters having less than three accidents during the reporting period were discarded. The remaining accidents were entered into a computer program to calculate preliminary hazard index values.

Number of accidents, accident rates and severity indexes were calculated for sixty eight cluster sites. Table 3. is a summary of the screening program. The cluster sites were ranked according to the composite value of the three indexes. Many of the sites were eliminated from consideration because they were either on the FAU system or because jurisdiction limits had changed in the past four years. A recommended list of new sites was sent to Yellowstone County for their approval. The list was modified due to overlapping jurisdiction and other valid reasons and the final list of 15 new sites was approved.

TABLE 3.
YELLOWSTONE COUNTY ACCIDENT CLUSTER
SITE SELECTION MATRIX PRELIMINARY

SITE RANK NO.	MAJOR ROUTE	INTERSECTION OR LOCATION	ACCIDENTS / YEAR				TOTAL NO.		APPROX. VOLUME	ACC.		SVRTY INDEX	COMPOSITE SCREEN INDEX	REMARKS
			84	85	86	87	ACC. INDEX	ACC. RATE		INDEX	INDEX			
1	72ND STREET W.	LAUREL AIRPORT RD	5	6	1	2	14	76	1200	7.99	100	51	77.2	OK
2	OLD BLUE CR. RD.	E. OF BLUE CR. RD.	2	1	1	1	5	50	500	6.85	100	65	74.5	OK
3	CA ROAD	SCANDIA ROAD	2	0	2	1	5	50	500	6.85	99	57	71.4	OK
4	INDIAN CAVES ROAD	5.8 MILES SOUTH	2	1	1	1	5	50	500	6.85	100	53	70.4	OK
5	US 87	5-7 MILES EAST	2	3	2	1	8	61	1000	5.48	100	37	68.2	OK
6	GARDEN AVENUE	N. OF SUGAR AVE.	2	1	3	1	7	58	400	11.99	100	32	65.7	OK
7	OLD HARDIN ROAD	CLAYTON ST. +/-	9	3	0	1	13	74	2000	4.45	76	39	63.0	OK
8	SHEPHERD ROAD	SHEPHERD-ACTON RD	3	5	2	2	12	72	2100	3.91	69	45	61.9	PREVIOUS STUDY
9	SUGAR AVENUE	GARDEN AVENUE	2	1	3	0	6	54	800	5.14	83	40	60.8	CITY LIMITS ?
10	BENCH BOULEVARD	TWO MOON PARK RD.	5	3	0	3	11	69	1800	4.19	73	38	60.1	OK
11	DRURY LANE	HOSKINS ROAD	2	1	1	0	4	45	600	4.57	77	51	59.7	OK
12	72ND STREET W.	BN TRACKS	4	0	0	2	6	54	1500	2.74	53	64	56.9	OK
13	COBURN ROAD	N. OF ROSEBUD	3	0	0	2	5	50	1000	3.42	63	53	55.9	PREVIOUS STUDY
14	12 MILE ROAD	HOMER DAVIS ROAD	1	0	1	2	4	45	600	4.57	77	37	54.8	PREVIOUS STUDY
15	JELLISON ROAD	CURVES	2	2	1	4	9	64	2100	2.94	56	40	52.9	PREVIOUS STUDY
16	OLD HIGHWAY 10	3.5 MI. W LAUREL	2	2	0	2	6	54	1200	3.42	63	40	52.8	OK
17	VALLEY DRIVE	NEAR COVE DITCH	1	2	0	2	5	50	1000	3.42	63	42	52.4	OK
18	YELL. RIVER ROAD	N OF BENCH BLVD	4	3	2	0	9	64	1800	3.42	63	30	52.4	CITY LIMITS
19	LAKE ELMO ROAD	ROBERTSON LANE	4	2	1	0	7	58	1500	3.20	60	38	52.0	CITY LIMITS
20	HIGHWAY 312	SHEPHERD ROAD	2	3	1	3	9	64	3800	1.62	35	58	50.6	PREVIOUS STUDY
21	HIGHWAY 312	McGIRL ROAD	3	5	1	3	12	72	5300	1.55	34	51	50.2	PREVIOUS STUDY
22	ROAD 15 N.	N. OF 312	1	1	2	1	5	50	1000	3.42	63	35	49.9	OK
23	BLUE CREEK ROAD	PRYOR CR. ROAD	1	1	0	3	5	50	1500	2.28	46	53	49.6	OK
24	CENTRAL AVENUE	56TH STREET W.	0	0	1	6	7	58	2500	1.92	40	54	49.6	OK
25	HIGHWAY 312	HUNTLEY TURNOUT	0	3	0	2	5	50	2300	1.49	33	68	49.2	PREVIOUS SYUDY
26	NEIBAUER ROAD	64TH STREET W.	1	2	0	1	4	45	1000	2.74	53	45	48.3	ALTERNATE
27	HIGHWAY 312	RIVER BRIDGE	0	3	0	1	4	45	2300	1.19	27	73	47.5	ALTERNATE
28	GRAND AVENUE	48TH STREET W.	1	2	1	2	6	54	1900	2.16	44	45	47.3	ALTERNATE
29	NEIBAUER ROAD	48TH STREET W.	1	1	1	2	5	50	1500	2.28	46	42	45.9	ALTERNATE
30	S. FRONTAGE ROAD	56TH STREET W.	2	1	2	2	7	58	5000	0.96	23	63	45.7	ALTERNATE
31	SHEPHERD ROAD	KIRBY ROAD	2	1	1	0	4	45	1200	2.28	46	45	45.6	ALTERNATE
32	YARD OFFICE ROAD	1.5 MILE NE LAUREL	1	1	2	0	4	45	1000	2.74	53	37	45.6	ALTERNATE
33	HIGHWAY 312	FIVE CORNERS INTER	4	4	3	1	12	72	5000	1.64	35	35	45.3	MOOH PROJECT
34	HIGHWAY 312	DOVER ROAD	8	1	2	3	14	76	8000	1.20	27	41	45.3	PREVIOUS STUDY

TABLE 3. CONT.

SITE RANK NO.	MAJOR ROUTE	INTERSECTION OR LOCATION	TOTAL NO. ACCIDENTS / YEAR				NO. ACC. ACC. INDEX	APPROX. VOLUME	ACC. RATE		SVRTY INDEX	COMPOSITE SCREEN INDEX		REMARKS
			84	85	86	87			84	85				
35	NORTH FRONTAGE RD	JOHNSON LANE	1	3	1	1	6	54	2000	2.05	42	40	44.9	ALTERNATE
36	OLD HIGHWAY 10	GOLF COURSE RD	1	3	1	0	5	50	1400	2.45	49	35	44.4	PREVIOUS STUDY
37	GRAND AVENUE	54TH STREET W.	3	1	1	1	6	54	1900	2.16	44	33	43.3	PREVIOUS SYUDY
38	SHEPHERD ROAD	CHICAGO ROAD	1	0	1	2	4	45	1600	1.71	37	45	41.9	PREVIOUS STUDY
39	SHEPHERD ROAD	HOMER DAVIS RD	1	0	2	1	4	45	1600	1.71	37	45	41.9	PREVIOUS STUDY
40	HIGHWAY 312	5 MILES EAST	2	3	1	1	7	58	6000	0.80	19	54	41.5	ALTERNATE
41	HIGHWAY 312	BITTERROOT LANE	0	2	2	3	7	58	6500	0.74	18	54	41.0	ALTERNATE
42	ROSEBUD LANE	COBURN ROAD	2	1	1	0	4	45	1000	2.74	53	22	40.9	PREVIOUS STUDY
43	METRA PARKING	UPPER LOT	0	0	8	2	10	67	8000	0.86	21	42	40.6	ALTERNATE
44	KING AVENUE	64TH STREET W.	0	2	0	2	4	45	1800	1.52	33	45	40.6	ALTERNATE
45	NEIBAUER ROAD	W. OF SHILO	0	0	2	3	5	50	2900	1.18	27	48	40.3	PREVIOUS STUDY
46	HIGHWAY 312	GRELCK LANE	1	0	3	6	10	67	6000	1.14	26	35	40.3	ALTERNATE
47	BITTERROOT DRIVE	YELL. RIVER ROAD	2	2	0	0	4	45	1500	1.83	39	37	39.9	ALTERNATE
48	PRYOR CREEK RD	20 MILES S. BILL.	1	1	1	1	4	45	2000	1.37	31	45	39.5	ALTERNATE
49	HIGHWAY 312	SEVEN MILE BRIDGE	1	2	3	2	8	61	5000	1.10	25	37	39.1	ALTERNATE
50	OLD HARDIN ROAD	HARDIN ROAD	3	1	0	3	7	58	8000	0.60	15	51	38.8	MDOH PROJECT
51	HIGHWAY 312	DRURY LANE	0	2	2	1	5	50	5800	0.59	15	57	38.5	PREVIOUS STUDY
52	S. FRONTAGE ROAD	WEIGH STATION	2	0	3	0	5	50	5000	0.68	17	49	36.7	ALTERNATE
53	S. FRONTAGE ROAD	DUCK CREEK ROAD	2	0	2	1	5	50	5000	0.68	17	48	36.4	ALTERNATE
54	OLD HARDIN ROAD	BECAFT LANE	1	2	1	3	7	58	6000	0.80	19	38	36.3	PREVIOUS STUDY
55	HIGHWAY 312	7.5 MILES EAST	1	1	1	1	4	45	5000	0.55	14	51	35.1	ALTERNATE
56	NORTH FRONTAGE RD	US 87	4	1	1	1	7	58	20000	0.24	7	47	34.4	MDOH PROJECT
57	METRA ACCESS	6TH AVENUE N.	0	1	4	0	5	50	8000	0.43	11	48	34.2	ALTERNATE
58	S. FRONTAGE ROAD	E. LAUREL TR. STOP	2	1	1	1	5	50	5000	0.68	17	41	34.2	ALTERNATE
59	JELLISON ROAD	BLUE CREEK ROAD	0	2	1	1	4	45	4500	0.61	15	45	33.6	MDOH PROJECT
60	HIGHWAY 312	JUST N OF US 87	0	2	2	0	4	45	8000	0.34	9	51	33.3	ALTERNATE
61	S. FRONTAGE ROAD	ALLENDALDE RD.	0	2	0	2	4	45	5000	0.55	14	45	33.1	ALTERNATE
62	GRAND AVENUE	SHILOH ROAD	4	1	1	0	6	54	9000	0.46	12	40	33.0	ALTERNATE
63	OLD HARDIN ROAD	JOHNSON LANE	4	4	1	0	9	64	8000	0.77	19	22	32.7	PREVIOUS STUDY
64	S. FRONTAGE ROAD	SHILOH RD.	1	0	1	2	4	45	6000	0.46	12	45	32.3	ALTERNATE
65	OLD HARDIN ROAD	McINTOSH	2	2	0	0	4	45	2000	1.37	31	22	32.0	ALTERNATE
66	HIGHWAY 312	BARRY ROAD	3	0	0	1	4	45	6500	0.42	11	45	31.9	PREVIOUS STUDY
67	OLD HARDIN ROAD	PICCOLD LANE	2	1	0	1	4	45	7000	0.39	10	37	28.9	PREVIOUS STUDY
68	COBURN ROAD	HWY 87 LOCKWOOD	3	1	1	0	5	50	16000	0.21	6	35	27.8	PREVIOUS STUDY
TOTALS =			134	109	87	100	430	54	3741	2.34	42	45	46.2	REPRESENTS 27% OF
AVE. YEAR =			107					AVE.	AVE.	AVE.	AVE.	AVE.	AVE.	ALL COUNTY ACC.

Seven of the 1985 study sites ranked within the top 22 valid sites on the list. These sites were included in this study so that they could be ranked according to project priorities. Valid sites remaining in the selection list were not included in the study since the scope of work only allows for fifteen new sites.

Phase 2 -Data Collection Phase; included the preliminary organization of the project including scheduling, site selection, form processing, field data location and reduction of data. Accident data was obtained from reports provided by the Department of Justice. Traffic counts were taken at each location. The average daily traffic was determined by applying factors for hourly, daily and monthly variations.

Other data collected in the field included measurement of road widths and geometrics, and inventory of traffic control devices, turning movement counts and subjective observation of traffic operations.

As it was collected data was entered into a microcomputer using Lotus 123 software. Specific templates were created which were used in the analysis.

Phase 3 - Analysis of Data; included the determination of hazard indexes for each location by using the Federal Highway Administration Report No. FHWA-RD-77-83 "Identification of Hazardous Locations". Computations involved with accidents, volumes, capacities, indicator values and other aspects of hazard indexes were performed on the microcomputer. From these computations a preliminary hazard ranking list was prepared.

Phase 4 - Evaluation of Corrective Measures and Priority Listing; included the determination of improvements that would reduce or eliminate certain types of hazards in general at the accident locations. Preliminary designs of those improvements included signing, geometric changes, signal modifications, channelization and reconstruction. The improvements were recommended on a short term basis. In most cases, the nature of the sites was such that long term improvements could not be recommended.

Cost effectiveness calculations of the improvements at each location were determined by preparing preliminary cost estimates and computing economic benefits to arrive at a benefit/cost ratio. The method used to determine benefit/cost ratios is identical to those used by Montana Department of Highways Project Planning Section. All values used in the formulation were supplied by Hank Butzlaff, supervisor of that section. The composite hazard index ranking and benefit/cost ratio then, determined the final priority listing.

ERROR ANALYSIS

The analysis of high hazard accident sites by the methods published in FHWA Report No. FHWA-RD-77-83 intrinsically contains some degree of error due to subjective data collection and computational bias. In the application of the method, certain other innate errors appear in various forms. A cursory analysis of these error sources and the relative degree of effect each has on the final index ranking is represented in this section.

SITE SELECTION

Site selection involved the use of the three major indexes used in the computation of hazard indexes. Therefore, then error of selecting sites that would not stand up to the analysis procedure was greatly reduced.

NUMBER OF ACCIDENTS INDICATOR

The average number of accidents per site was 6.5 which would result in an average indicator value of 53. Assuming the worst conditions for error analysis purposes, two reports may be incorrect either by misplaced location or lost, which would produce negative bias. One report would result in a negative bias of 9%.

ACCIDENT RATE INDICATOR

Since volume data for the exact period of accident reporting may not exist at some locations, factors adjusting past or present Average Daily Traffic (ADT) to the analysis period were used. Assuming the worst cases of no growth or double growth, the actual ADT during the reporting period would have been negative or positive bias of 6% in the indicator value.

The volume capacity indicator would present a similar bias of lesser magnitude due to ADT factoring.

HAZARD INDEX ERROR

Based on the foregoing assumptions the average hazard index of 60.5 could be negative or positive. It is unlikely that all bias would be directed in a positive or negative direction. It is most probable that compensating errors occurred in the majority of instances.

HAZARD INDEX - ANALYSIS RESULTS

Seven hazard indices were used as the preliminary basis of ranking hazardous sites. The following are brief descriptions of each index including data format, data collection, indicator scaling and site ranking with respect to each index.

1. **Number of Accidents** - This indicator provides a historical background of accidents at the investigation site. In the case of Yellowstone County a four year period was used, which included 1984 - 1987. The accident data had to be photo copied in Helena. The data represents all reports filed on county roads.

Figure 2 is a curve extracted from the FHWA report which is used to determine the indicator value. The data base is number of accidents per year. This indicator as all of the seven indicators used in the report is scaled between 0 and 100. An average of two accidents per year in a three year period indicates a hazardous location (indicator value of 33). Ten accidents on the average per year is used to designate a very hazardous location (indicator value of 67). In the case of this study where low volume rural roads are involved, the total accidents per site was used to extract the index value. This higher value is therefore more consistent with the level of the the other index values. Using an annual rate would scale down the importance of the number of accidents indicator.

Table 4 is the computer generated ranking of all sites based on this indicator.

TABLE 4. SITE RANKING BY NUMBER OF ACCIDENTS

SITE RANK NO.	MAJOR ROUTE	INTERSECTION OR LOCATION	ACCIDENTS / YEAR				TOTAL NO. ACC. INDEX	NO. ACC.
			84	85	86	87		
1	HIGHWAY 312	McGIRL ROAD	3	5	1	3	12	72
2	SHEPHERD RD.	SHEPHERD-ACTON RD.	3	5	2	2	12	72
3	BENCH BOULEVARD	TWO MOON PARK RD.	5	3	0	3	11	69
4	72ND STREET W.	LAUREL AIRPORT RD	4	4	1	2	11	69
5	HIGHWAY 312	SHEPHERD RD	2	3	1	3	9	64
6	JELLISON ROAD	CURVES	2	2	1	4	9	64
7	OLD HARDIN ROAD	CLAYTON ST. +/-	6	1	0	1	8	61
8	GARDEN AVENUE	N. OF SUGAR AVE.	2	1	3	1	7	58
9	CENTRAL AVENUE	56TH STREET W.	0	0	1	6	7	58
10	72ND STREET W.	BN TRACKS	4	0	0	2	6	54
11	INDIAN CAVES ROAD	5.8 MILES SOUTH	2	1	1	1	5	50
12	OLD BLUE CR. RD.	E. OF BLUE CR. RD.	2	1	1	1	5	50
13	ROAD 15 N.	N. OF 312	1	1	2	1	5	50
14	NEIBAUER ROAD	48TH STREET W.	1	1	1	2	5	50
15	HIGHWAY 312	HUNTLEY TUROUT	0	3	0	2	5	50
16	VALLEY DRIVE	NEAR COVE DITCH	1	2	0	2	5	50
17	DRURY LANE	HOSKINS ROAD	2	1	1	0	4	45
18	NEIBAUER ROAD	64TH STREET W.	1	2	0	1	4	45
19	COBURN ROAD	ROSEBUD LANE	2	1	1	0	4	45
20	12 MILE ROAD	HOMER DAVIS RD	1	0	1	2	4	45
21	CA ROAD	N. OF SCANDIA RD.	2	0	1	0	3	40
22	BLUE CREEK ROAD	PRYOR CR. ROAD	0	1	0	2	3	40
TOTALS =			46	38	19	41	144	54.7 AVE.
ANNUAL AVERAGES =			2.1	1.7	0.9	1.9	1.6	

2. Accident Rate Indicator - This indicator somewhat compensates for any incomplete information provided by the number of accident indicators in that an exposure value is provided by the relationship between accidents and the total volumes of vehicles using the facility.

The data base for this indicator is expressed as the number of accidents per million entering vehicles. In the case of an intersection, "million entering vehicles" is the sum of the daily average approach volumes on all legs of the intersection, multiplied by the number of days in the analysis period.

The accident rate indicator is a very important part of the hazard index ranking method and data collection is possible only when a continued program of traffic counting had been performed. Spot counts adjusted by yearly volume increases, seasonal variations, daily variations and hourly variations were necessary at most sites to develop an average daily traffic figure applied to the analysis period since documented counts were not available.

Figure 3 represents the graphic plot of accident rate versus indicator value. As before, the indicator value ranges between 0 and 100.

Table 5 is the computer generated ranking of sites based on this indicator.

TABLE 5. SITE RANKING BY ACCIDENT RATE

RANK NUMBER	INTERSECTION LOCATION	TOTAL ACCIDENTS 4 YEARS	1988 ADT	4 YEAR PERIOD ADT	ACCIDENTS PER MVE	ACC RATE IND VAL
1	INDIAN CAVES ROAD	5	200	196	17.47	100
2	GARDEN AVE. N. OF SUGAR AVE.	7	400	392	12.23	100
3	DRURY LANE & HOSKINS ROAD	4	250	245	11.18	100
4	OLD BLUE CREEK ROAD	5	110	110	31.13	100
5	BENCH BLVD. & TWO MOON PARK	11	1,100	1,078	6.99	100
6	CENTRAL AVENUE & 56TH STREET W	7	770	755	6.35	95
7	12 MILE ROAD & HOMER DAVIS ROA	4	N/A	550	4.98	82
8	ROAD 15N NORTH OF HWY 312	5	750	735	4.66	78
9	NEIBAUR ROAD & 48TH STREET W.	5	750	735	4.66	78
10	CA ROAD N. OF SCANDIA ROAD	3	450	441	4.66	78
11	SHEPHERD RD. & SHEPHERD -ACTON	12	N/A	2,100	3.91	69
12	72ND STREET W. & LAUREL AIRPOR	11	2,230	2,185	3.45	63
13	COBURN ROAD & ROSEBUD LANE	4	N/A	950	2.88	55
14	JELLISON ROAD CURVES	9	N/A	2,150	2.87	55
15	NEIBAUR ROAD & 64TH STREET W.	4	1,000	980	2.80	54
16	BLUE CREEK ROAD & PRYOR CREEK	3	810	794	2.59	51
17	VALLEY DRIVE NEAR COVE DITCH	5	1,350	1,323	2.59	51
18	72ND STREET W. AT R.R. TRACKS	6	1,800	1,764	2.33	47
19	OLD HARDIN ROAD & CLAYTON	8	2,900	2,842	1.93	40
20	HIGHWAY 312 & SHEPHERD RD	9	N/A	3,700	1.67	36
21	HIGHWAY 312 & MCGIRL ROAD	12	N/A	5,200	1.58	34
22	HIGHWAY 312 & HUNTLEY TURNOUT	5	N/A	2,280	1.50	33
AVERAGE VALUES =		7		1,432	6.11	68

3. Accident Severity Indicator - Although there are many factors involved in the severity of accidents, statistical studies over a significant number of years have given fairly reliable dollar values in terms of economic loss for each type of accident. The accident severity indicator correlates a probable cause and effect relationship which aids in the determination of the level of accident reduction measures required. Severity values can also be used as a determinant of benefits resulting from various improvements.

The data base for accident severity is average relative severity in thousands of dollars. Data collection necessary for the use of the severity index is made possible by the accident report form.

The FHWA report presents the relative severity index values for each type of accident. Once the type of accident has been established, Figure 4 enables the user to assess the indicator value. Figure 4 is a graphic plot of the average severity in thousands of dollars versus the indicator value which is based on a scale of 0 to 100.

Table 6. is the computer generated ranking of sites based on this indicator.

TABLE 6. SITE RANKING BY ACCIDENT SEVERITY

RANK NO.	INTERSECTION LOCATION	SUM OF SEVERITY VALUES	TOTAL NO. ACC.	AVERAGE SEVERITY INDEX	INDICATOR VALUE
1	HIGHWAY 312 & HUNTLEY TURNOUT	\$264,800	5	\$52,960	100
2	OLD BLUE CREEK ROAD	\$255,600	5	\$51,120	100
3	72ND STREET W. AT R.R. TRACKS	\$266,400	6	\$44,400	100
4	HIGHWAY 312 & SHEPHERD RD	\$280,400	9	\$31,156	100
5	CA ROAD N. OF SCANDIA ROAD	\$32,400	3	\$10,800	66
6	CENTRAL AVENUE & 56TH STREET W.	\$66,400	7	\$9,486	63
7	INDIAN CAVES ROAD	\$44,800	5	\$8,960	62
8	HIGHWAY 312 & MCGIRL ROAD	\$102,000	12	\$8,500	60
9	DRURY LANE & HOSKINS ROAD	\$34,000	4	\$8,500	60
10	BLUE CREEK ROAD & PRYOR CREEK ROAD	\$23,200	3	\$7,733	58
11	SHEPHERD RD. & SHEPHERD -ACTON	\$74,400	12	\$6,200	53
12	NEIBAUR ROAD & 64TH STREET W.	\$24,800	4	\$6,200	53
13	VALLEY DRIVE NEAR COVE DITCH	\$26,400	5	\$5,280	50
14	NEIBAUR ROAD & 48TH STREET W.	\$26,400	5	\$5,280	50
15	OLD HARDIN ROAD & CLAYTON	\$40,400	8	\$5,050	49
16	JELLISON ROAD CURVES	\$42,000	9	\$4,667	48
17	BENCH BLVD. & TWO MOON PARK	\$45,200	11	\$4,109	45
18	72ND STREET W. & LAUREL AIRPORT RD	\$45,200	11	\$4,109	45
19	12 MILE ROAD & HOMER DAVIS ROAD	\$15,600	4	\$3,900	45
20	ROAD 15N NORTH OF HWY 312	\$17,200	5	\$3,440	42
21	GARDEN AVE. N. OF SUGAR AVE.	\$20,400	7	\$2,914	40
22	COBURN ROAD & ROSEBUD LANE	\$6,400	4	\$1,600	31
TOTAL SEVERITY \$ =		\$1,754,400			
TOTAL NO. ACC. =			144		
AVE. SEVERITY / ACC. =				\$12,183	
AVE. IND. VAL / SITE =					70

4. Volume to Capacity Ratio Indicator - This indicator not only produces exposure rates but also incorporates existing roadside features and conditions such as traffic type, turning directions, volume mix and number of lanes.

Computation of the volume capacity indicator is expressed as follows:

$$V/C = ADT/24 \text{ HOUR CAPACITY}$$

Again the low volume nature of these sites would dilute the relative importance of this indicator if calculated in this manner. Therefore, volume/capacity calculation using the 1985 Highway Capacity Manual procedures were used and expressed as a peak hour V/C. If the above formula were used, the maximum index value would have been less than 10 and more than half of the sites would have been at or near zero.

Data required for the volume capacity ratio involves field measurements of existing geometrics, turning counts and volume mix. The capacity of each section of road or intersection is computed through methodology presented in the 1985 Highway Capacity Manual using FHWA computer software. Although this indicator is cumbersome to use by nonexperienced personnel, its inclusion is considered necessary and correlates well in hazardous index ranking.

Figure 5. presents a graphic plot of the volume capacity ratio versus the indicator value which is also scaled between 0 and 100.

Table 7. is the computer generated ranking of the sites based on this indicator.

TABLE 7. SITE RANKING BY VOLUME/CAPACITY RATIOS

RANK NUMBER	INTERSECTION LOCATION	PEAK HOUR CAPACITY	PEAK HOUR FLOW	V/C RATIO	V/C INDICATOR VALUE
1	VALLEY DRIVE NEAR COVE DITCH	210	130	0.62	89
2	HIGHWAY 312 & MCGIRL ROAD	1000	500	0.50	77
3	OLD HARDIN ROAD & CLAYTON	800	285	0.36	61
4	JELLISON ROAD CURVES	650	210	0.32	57
5	72ND STREET W. AT R.R. TRACKS	596	190	0.32	56
6	HIGHWAY 312 & SHEPHERD RD	1300	370	0.28	52
7	HIGHWAY 312 & HUNTLEY TURNOUT	900	230	0.26	48
8	BENCH BLVD. & TWO MOON PARK	600	110	0.18	38
9	SHEPHERD RD. & SHEPHERD -ACTON	1200	210	0.18	37
10	72ND STREET W. & LAUREL AIRPORT RD	1280	220	0.17	37
11	CA ROAD N. OF SCANDIA ROAD	312	45	0.14	32
12	COBURN ROAD & ROSEBUD LANE	900	95	0.11	26
13	ROAD 15N NORTH OF HWY 312	800	75	0.09	24
14	BLUE CREEK ROAD & PRYOR CREEK ROAD	940	80	0.09	22
15	NEIBAUR ROAD & 64TH STREET W.	1230	100	0.08	22
16	GARDEN AVE. N. OF SUGAR AVE.	521	40	0.08	21
17	INDIAN CAVES ROAD	262	20	0.08	21
18	CENTRAL AVEUE & 56TH STREET W.	1250	80	0.06	18
19	NEIBAUR ROAD & 48TH STREET W.	1240	75	0.06	18
20	12 MILE ROAD & HOMER DAVIS ROAD	1200	55	0.05	14
21	DRURY LANE & HOSKINS ROAD	910	25	0.03	10
22	OLD BLUE CREEK ROAD	557	11	0.02	8
AVERAGE VALUES		848	143	0.18	36

* CAPACITIES BASED ON LEVEL-OF-SERVICE "C"

5. Sight Distance Indicator - This indicator is of significant value in rural locations, especially at intersecting roads. Even though the weighting factor in the hazard index computation is low, it is still considered valuable in determining deficiencies on unimproved county roads.

The data format for using the sight distance indicator is the ratio of actual sight distance to desirable sight distance. The FHWA report presents the minimum stopping sight distance on wet pavement for the various design speeds. Actual stopping sight distance is the

distance from the drivers position to the point where a stop may be required to avoid a hazardous maneuver or direct collision.

The data format for this indicator is the sight distance ratio of actual over desirable. Collection of the sight distance data requires field measurements of sight distance and determination of average travel speeds. Figure 6. presents a graphic plot of the sight distance ratio versus the indicator value which ranges from 0 to 100.

Table 8. is the computer generated ranking of sites based on this indicator.

TABLE 8. SITE RANKING BY SIGHT DISTANCE

RANK NUMBER	INTERSECTION LOCATION	N REQ SD	IND SD RATIO VAL	S REQ SD	IND SD RATIO VAL	E REQ SD	IND SD RATIO VAL	W REQ SD	IND SD RATIO VAL	#WT. IND VAL
1	CENTRAL AVENUE & 56TH STREET W.	1000 525 1.90	0	600 525 1.14	27	400 800 0.5	100	400 800 0.5	100	100
2	COBURN RD & ROSEBUD LANE	200 550 0.36	100	250 550 0.45	100	100 400 0.25	100	0		100
3	JELLISON ROAD CURVE	0		0		200 650 0.31	100	200 650 0.31	100	100
4	OLD BLUE CREEK ROAD	0		0		180 525 0.34	100	180 525 0.34	100	100
5	VALLEY DRIVE NEAR COVE DITCH	150 275 0.54	99	150 275 0.54	99					99
6	SHEPHERD RD & SHEP. - ACTON	500 600 0.83	52	350 600 0.58	91	400 200 2.00	100	500 525 0.95	40	97
7	CA ROAD N. OF SCANDIA ROAD	300 525 0.57	94	300 525 0.57	94	0		0		94
8	GARDEN AVE. N. OF SUGAR AVE.	120 200 0.6	88	120 200 0.6	88	150 200 0.75	62	150 200 0.75	62	88
9	BENCH BLVD. & TWO MOON PARK	1000 550 1.81	2	300 550 0.54	99	300 275 1.09	30	350 275 1.27	20	76
10	72ND STREET W. AT R.R. TRACKS	350 525 0.66	75	350 525 0.66	75	0		0		75
11	72ND STREET W & LAUREL AIR. RD	1500 800 1.87	1	1200 800 1.5	11	300 525 0.57	94	1000 525 1.90	0	66
12	INDIAN CAVES ROAD	0		0		200 275 0.72	65	200 275 0.72	65	65
13	HIGHWAY 312 & HUNTLEY APP. RD	500 275 1.82	2	0		2000 800 2.50	0	500 800 0.63	82	55
14	NEIBAUR ROAD & 48TH STREET W.	600 525 1.14	27	400 525 0.76	60	1600 800 2	0	1200 800 1.5	11	49
15	OLD HARDIN ROAD & CLAYTON	150 200 0.75	62	0		1000 550 1.81	2	1200 550 2.18	0	42
16	HIGHWAY 312 & MCGIRL RD	500 525 0.95	40	800 525 1.52	10	2000 800 2.50	0	2000 800 2.50	0	30
17	NEIBAUR ROAD & 64TH STREET W.	1600 800 2	0	800 800 1	37	800 525 1.52	10	800 800 1	37	28
18	HIGHWAY 312 & SHEPHERD RD	1100 525 2.10	0	500 525 0.95	40	2000 800 2.50	0	2000 800 2.50	0	27
19	ROAD 15N NORTH OF HWY 312	300 200 1.5	11	300 200 1.5	11					11
20	12 MILE RD & HOMER DAVIS RD	1600 800 2.00	0	1600 800 2	0	800 525 1.52	10	800 525 1.52	10	10
21	DRURY LANE & HOSKINS ROAD	1500 800 1.87	1	1500 800 1.87	1	800 525 1.52	10	0		7
22	BLUE CREEK ROAD & PRYOR CR RD	1500 800 1.87	1	1600 800 2	0	1200 525 2.28	0			2

AVERAGE INDICATOR VALUE = 60.0

6. Driver Expectancy Indicator - This indicator relates human behavior factors to existing road conditions. The value of this indicator is realized in the fact that the roadway geometrics and roadside culture are evaluated on a human judgement basis.

The data format for the driver expectancy index is the problem rating scale. Being a subjective indicator, the degree of expectancy is rated on a scale from 1 to 6, and the expectancy rating varies linearly with the indicator value as shown in Figure 7. The expectancy rating form can be found in the FHWA report for further reference.

Table 9. is the computer generated ranking of sites based on this indicator.

TABLE 9. SITE RANKING BY DRIVER EXPECTANCY

RANK NUMBER	INTERSECTION LOCATION	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	CA ROAD N. OF SCANDIA ROAD	6	6			6.0	100
2	72ND STREET W. AT R.R. TRACKS	6	5			5.5	92
3	BENCH BLVD. & TWO MOON PARK	6	4			5.0	83
4	GARDEN AVE. N. OF SUGAR AVE.	5	5			5.0	83
5	JELLISON ROAD CURVES			6	4	5.0	83
6	INDIAN CAVES ROAD	5	4			4.5	75
7	NEIBAUR ROAD & 48TH STREET W.	5	6	4	3	4.5	75
8	VALLEY DRIVE NEAR COVE DITCH	5	4			4.5	75
9	HIGHWAY 312 & HUNTLEY TURNOUT	4		6	3	4.3	72
10	72ND STREET W. & LAUREL AIRPORT RD	4	4	4	5	4.3	71
11	COBURN ROAD & ROSEBUD LANE	4	2		6	4.0	67
12	HIGHWAY 312 & SHEPHERD RD	4	3	5	4	4.0	67
13	SHEPHERD RD. & SHEPHERD -ACTON	5	5	3	3	4.0	67
14	NEIBAUR ROAD & 64TH STREET W.	4	3	5	3	3.8	63
15	HIGHWAY 312 & McGIRL ROAD	3	4	4	3	3.5	58
16	OLD BLUE CREEK ROAD			4	3	3.5	58
17	ROAD 15N NORTH OF HWY 312	3	4			3.5	58
18	CENTRAL AVENUE & 56TH STREET W.	3	3	3	4	3.3	54
19	OLD HARDIN ROAD & CLAYTON			3	3	3.0	50
20	12 MILE ROAD & HOMER DAVIS ROAD	2	4	3	2	2.8	46
21	BLUE CREEK ROAD & PRYOR CREEK ROAD	3	3	2		2.7	44
22	DRURY LANE & HOSKINS ROAD	3	3	2		2.7	44
AVERAGE INDICATOR VALUE 67.6							

7. Information System Deficiencies Indicator - This indicator also provides a value or subjective judgement on the sufficiency of traffic control devices which transfer necessary information to the operator.

The data format for the information system deficiencies indicator is similar to that of the driver expectancy indicator in that a value form is used to provide a rating between 1 and 6. The rating for this indicator is also plotted linearly between the indicator range values of 0 and 100 and is shown on Figure 8. The value rating form is for the information system deficiencies indicator. It is also presented in the FHWA report for further reference.

Table 10. is the computer generated ranking of sites based on this indicator.

TABLE 10. SITE RANKING BY INFORMATION DEFICIENCY

RANK NUMBER	INTERSECTION LOCATION	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	INDIAN CAVES ROAD			6	6	6.0	100
2	OLD BLUE CREEK ROAD			6	6	6.0	100
3	CA ROAD N. OF SCANDIA ROAD	5	5			5.0	83
4	VALLEY DRIVE NEAR COVE DITCH	5	5			5.0	83
5	72ND STREET W. AT R.R. TRACKS	4	5			4.5	75
6	HIGHWAY 312 & HUNTLEY TURNOUT	5		4	4	4.3	72
7	72ND STREET W. & LAUREL AIRPORT RD	4	4	3	5	4.0	67
8	BENCH BLVD. & TWO MOON PARK	4	4			4.0	67
9	GARDEN AVE. N. OF SUGAR AVE.	4	4			4.0	67
10	NEIBAUR ROAD & 48TH STREET W.	2	4	5	5	4.0	67
11	NEIBAUR ROAD & 64TH STREET W.	5	5	3	3	4.0	67
12	OLD HARDIN ROAD & CLAYTON			4	4	4.0	67
13	ROAD 15N NORTH OF HWY 312	4	4			4.0	67
14	BLUE CREEK ROAD & PRYOR CREEK ROAD	4	4	3		3.7	61
15	12 MILE ROAD & HOMER DAVIS ROAD	4	4	3	3	3.5	58
16	CENTRAL AVEUE & 56TH STREET W.	3	3	4	4	3.5	58
17	HIGHWAY 312 & MCGIRL ROAD	4	4	3	3	3.5	58
18	HIGHWAY 312 & SHEPHERD RD	3	3	5	3	3.5	58
19	COBURN ROAD & ROSEBUD LANE	4	4		2	3.3	56
20	DRURY LANE & HOSKINS ROAD	4	4	2		3.3	56
21	SHEPHERD RD. & SHEPHERD -ACTON	3	4	3	2	3.0	50
22	JELLISON ROAD CURVES			2	2	2.0	33

AVERAGE INDICATOR VALUE = 66.8

HAZARD RANKING

Once all of the data had been collected and the indicator values computed, indicator values and necessary data were transferred to the hazard index computation matrix. Each indicator is weighted in accordance with the FHWA report. The weighting factors are fractional portions of unity. When all nine indicators established in FHWA report are used, the sum of weights is equal to one. In the case of Yellowstone County, two indicators were omitted, the Traffic Conflict Indicator and the Erratic Maneuvers Indicator. Their exclusion from the study was not felt to be any deterrent in the ranking of hazardous sites. The use of seven indicators provides an 88.6% confidence in strength of evaluation.

Based on the hazard analysis for each site, a matrix of indicator values and final hazard index ratings was constructed on the Lotus system a hazard index ranking was completed. Table 11. lists this ranking by site number, location, indicator values and hazard index. Also shown is statistical information for the indicator values and hazard index.

During the process of field data collection and subsequent indicator computations, it was discovered that the two entirely subjective indicators could vary widely between consecutive analyses among non-experienced observers. Yellowstone County will most likely retain traffic personnel who will update the high hazard priority list and therefore these indicators should remain as part of the hazard index ranking.

TABLE 11. SITE RANKING BY HAZARD INDEX VALUES - SUMMARY OF INDICATOR VALUES

		# OF ACC.		ACC. RATE		SEVERITY		V/C RATIO		SIGHT DIST		EXPECT.		INFO DEF.		TOTAL	
RANK		IND	PART	IND	PART	IND	PART	IND	PART	IND	PART	IND	PART	IND	PART		
NUMBER	INTERSECTION LOCATION	VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.		HAZARD INDEX
* RELATIVES WEIGHTS :		0.163		0.224		0.190		0.082		0.074		0.148		0.115		1.000	
1	OLD BLUE CREEK ROAD	50	8.15	100	22.40	100	19.00	8	0.66	100	7.40	58	8.58	100	11.50		77.69
2	INDIAN CAVES ROAD	50	8.15	100	22.40	62	11.78	21	1.72	65	4.81	75	11.10	100	11.50		71.46
3	BENCH BLVD. & TWO MOON PARK	69	11.25	100	22.40	45	8.55	38	3.12	76	5.62	83	12.28	67	7.71		70.93
4	72ND STREET W. AT R.R. TRACKS	54	8.80	47	10.53	100	19.00	56	4.59	75	5.55	92	13.62	75	8.63		70.71
5	CA ROAD N. OF SCANDIA ROAD	40	6.52	78	17.47	66	12.54	32	2.62	94	6.96	100	14.80	83	9.55		70.46
6	GARDEN AVE. N. OF SUGAR AVE.	58	9.45	100	22.40	40	7.60	21	1.72	88	6.51	83	12.28	67	7.71		67.68
7	CENTRAL AVENUE & 56TH STREET W.	58	9.45	95	21.28	63	11.97	18	1.48	100	7.40	54	7.99	58	6.67		66.24
8	VALLEY DRIVE NEAR COVE DITCH	50	8.15	51	11.42	50	9.50	89	7.30	99	7.33	75	11.10	83	9.55		64.34
9	SHEPHERD RD. & SHEPHERD -ACTON	72	11.74	69	15.46	53	10.07	37	3.03	97	7.18	67	9.92	50	5.75		63.14
10	HIGHWAY 312 & HUNTLEY TURNOUT	50	8.15	33	7.39	100	19.00	48	3.94	55	4.07	72	10.66	72	8.28		61.48
11	HIGHWAY 312 & SHEPHERD RD	64	10.43	36	8.06	100	19.00	52	4.26	27	2.00	67	9.92	58	6.67		60.34
12	JELLISON ROAD CURVES	64	10.43	55	12.32	48	9.12	57	4.67	100	7.40	83	12.28	33	3.80		60.03
13	NEIBAUR ROAD & 48TH STREET W.	50	8.15	78	17.47	50	9.50	18	1.48	49	3.63	75	11.10	67	7.71		59.03
14	72ND STREET W. & LAUREL AIRPORT	54	8.80	63	14.11	45	8.55	37	3.03	66	4.88	71	10.51	67	7.71		57.60
15	DRURY LANE & HOSKINS ROAD	45	7.34	100	22.40	60	11.40	10	0.82	7	0.52	44	6.51	56	6.44		55.43
16	HIGHWAY 312 & MCGIRL ROAD	72	11.74	34	7.62	60	11.40	77	6.31	30	2.22	58	8.58	58	6.67		54.54
17	ROAD 15N NORTH OF HWY 312	50	8.15	78	17.47	42	7.98	24	1.97	11	0.81	58	8.58	67	7.71		52.67
18	COBURN ROAD & ROSEBUD LANE	45	7.34	55	12.32	31	5.89	26	2.13	100	7.40	67	9.92	56	6.44		51.43
19	OLD HARDIN ROAD & CLAYTON	61	9.94	40	8.96	49	9.31	61	5.00	42	3.11	50	7.40	67	7.71		51.43
20	NEIBAUR ROAD & 64TH STREET W.	45	7.34	54	12.10	53	10.07	22	1.80	28	2.07	63	9.32	67	7.71		50.41
21	12 MILE ROAD & HOMER DAVIS ROAD	45	7.34	82	18.37	45	8.55	14	1.15	10	0.74	46	6.81	58	6.67		49.62
22	BLUE CREEK ROAD & PRYOR CREEK RD	40	6.52	51	11.42	58	11.02	22	1.80	2	0.15	44	6.51	61	7.02		44.44
AVERAGE VALUES :		53.9	8.79	68.1	15.26	60.0	11.40	35.8	2.94	60.0	4.44	67.5	9.99	66.8	7.68		60.50
STANDARD DEVIATIONS :		9.5	1.54	23.4	5.26	20.5	3.90	21.3	1.75	34.5	2.56	14.9	2.21	14.8	1.70		8.56

* SINCE 2 CONFLICT INDICATORS WERE OMITTED FROM THE PROCEDURE,
THE PUBLISHED WEIGHT FACTORS WERE DIVIDED BY .386 TO ADJUST FOR
THE RELATIVE STRENGTH OF EVALUATION.

EXPLANATION OF IMPROVEMENTS

The recommended improvements presented within this report are of two types. Short term improvements indicate the minimum amount of upgrading or modifications necessary to increase driver expectancy and to update the site to current standards. Long term improvements are normally considered viable when severe conditions at the site prevent short term improvements from completely satisfying the control measures necessary to prevent future problems. Since all of the long term improvements are dependant upon significant changes in the future operations and most of the sites were not of a nature that reliable predictions could be made, no costs or project ranking was completed. Many of the recommended improvements have sufficient latitude so that alternative measures could be suggested during design. The selection of recommended improvements was based on subjective engineering judgement.

At numerous sites it was noted that many traffic control devices were not in compliance with MUTCD. There were also several locations where deficiencies may be critical and should be corrected as soon as possible. In some cases, the recommended improvements will require precise layout in the field and an experienced traffic engineer should be consulted to ensure that the improvements are constructed in accordance with the intent of the planned improvements.

The improvement sketches in all cases should not be considered design plans. Those drawings are preliminary and are intended to present the improvement concepts only in enough detail to provide a general idea of the costs which could be anticipated. In some cases, detailed survey data and design research will be necessary prior to preparation of final plans.

BENEFIT/COST RATIOS

Costs - are developed by preliminary estimation of required quantities based either on current prices as tabulated from average bid prices of similar projects or, where applicable, on prices established by Montana Department of Highways Project Planning Section. The costs should in no way be considered a quote or final estimate of actual work.

The following are traffic control devices and allowable costs that are eligible for funding by the Montana Department of Highways through their Off-System Safety Program:

A. Signs:

- | | |
|---------------------------------------|-------------|
| 1. 1 square foot to 6 square feet | - \$ 100.00 |
| 2. 6.1 square feet to 10 square feet | - \$ 140.00 |
| 3. 10.1 square feet to 20 square feet | - \$ 170.00 |
| 4. supplementary sign on same post | - \$ 50.00 |

B. Delineators:

- | | |
|----------------------------------|------------|
| 1. Design "'A" metal posts | - \$ 9.25 |
| 2. Design "A" flexible posts-6' | - \$ 20.00 |
| 3. Design "A" flexible posts-27" | - \$ 6.00 |

C. Guardrail:

- | | |
|---------------------------------------|--------------|
| 1. New "W" Beam rail (per foot) | - \$ 8.00 |
| 2. "W" Beam end treatment (each) | - \$1,000.00 |
| 3. New concrete rail (per foot) | - \$ 16.00 |
| 4. New concrete end tapers (per foot) | - \$ 16.00 |

Even though Yellowstone County maintenance crews are capable of performing a good deal of work, costs related to physical changes in the roadway section are based on contract prices in order to correlate with costs requiring contract bid letting. The costs do not include administrative, engineering or field layout for the recommended improvements which would require bid letting. Engineering design will generally be required to produce contract plans and specifications. These costs should be evaluated prior to planning improvement projects.

Benefits - are estimated by applying accident reduction forecasts based on the type of improvement recommended. The forecasts are based on the subjective evaluation by an experienced traffic engineer. This evaluation is aided by knowledge of accident experience at similar intersections with the improvements existing. Also statistical studies relating certain improvements to accident reduction are used as a guide ie, Roy Jorgenson and Associates, "Evaluation of Criteria for Safety Improvements on the Highway" (Washington, D.C.: U.S. Bureau of Public Roads, Office of Highway Safety, 1966. p. 316).

The forecasted reduction is expressed as a percentage of each type of accident. This percentage is multiplied by the percentage of all accidents represented by each type. The total percent reduction of all accidents at each site is the sum of all accidents reduction percentages for each type.

The method used to compute benefits in this study follows the Montana Department of Highways procedures. Those procedures were programmed for the Lotus 123 Computer Software which provides a tabular summary of all variables in the computation.

If applied consistently, the economic benefit computation will provide a realistic estimate of average economic savings to the general society. The benefit amount should not be interpreted as a dollar value that Yellowstone County will receive as a result of dollar outlay. It is a figure used to quantify the economic benefit to society that would occur if a certain number of accidents did not occur.

Ratio - of benefits to cost provides a reference as to the value of the recommended improvements. It is the desire of any improvement project to have a benefit-cost (B/C) ratio in excess of 1.0. If the B/C is less than 1.0 the project would have questionable justification. In this study, only the Coburn Road - Rosebud Lane site has a B/C less than 1.0. Therefore it should not be considered in the final list of improvement projects. Table 10 is a computer generated summary of the B/C ranking for the twenty sites.

TABLE 12. SITE RANKING BY BENEFIT/COST RATIOS - CALCULATION SUMMARY

R A N K #	SITE LOCATION	C O S T S					B E N E F I T S					B/C RATIO	INDI VAL
		PROJ LIFE	CAPITOL COST	EQUIV ANNUAL COST	ANNUAL MAINT. COST CH.	TOTAL ANNUAL COST	Q	Afi	Apd	PFI Ppd	ANNUAL BENEFIT		
			IMPROVE	COST	COST CH.	COST							
1	DRURY LANE & HOSKINS ROAD	5	\$1,030	\$272	\$50	\$322	\$25,270	0.75	0.25	40% 0%	\$7,808	24.27	100
2	CENTRAL AVENUE & 56TH STREET W.	5	\$1,630	\$430	\$100	\$530	\$25,270	1.50	0.25	30% 20%	\$11,795	22.25	100
3	BLUE CREEK ROAD & PRYOR CREEK ROAD	5	\$900	\$237	\$50	\$287	\$25,270	0.50	0.25	35% 35%	\$4,699	16.35	93
4	72ND STREET W. & LAUREL AIRPORT RD	5	\$2,270	\$599	\$100	\$699	\$25,270	1.00	1.75	35% 34%	\$10,099	14.45	89
5	BENCH BLVD. & TWO MOON PARK	5	\$2,900	\$765	\$100	\$865	\$25,270	0.75	2.00	50% 35%	\$10,914	12.62	84
6	CA ROAD N. OF SCANDIA ROAD	5	\$2,420	\$638	\$50	\$688	\$25,270	0.75	0.00	40% 0%	\$7,808	11.34	81
7	NEIBAUER ROAD & 48TH STREET W.	5	\$1,600	\$422	\$100	\$522	\$25,270	0.50	0.75	40% 40%	\$5,700	10.92	80
8	INDIAN CAVES ROAD	5	\$3,320	\$876	\$50	\$926	\$25,270	1.00	0.25	35% 40%	\$9,275	10.02	77
9	HIGHWAY 312 & MCGIRL ROAD	10	\$12,760	\$2,077	\$400	\$2,477	\$25,270	2.00	1.00	40% 40%	\$21,481	8.67	72
10	HIGHWAY 312 & SHEPHERD RD	7	\$7,160	\$1,471	\$200	\$1,671	\$25,270	1.00	1.25	45% 35%	\$12,434	7.44	67
11	12 MILE ROAD & HOMER DAVIS	5	\$240	\$63	\$100	\$163	\$25,270	0.25	0.75	15% 15%	\$1,161	7.11	65
12	NEIBAUER ROAD & 64TH STREET W.	5	\$940	\$248	\$100	\$348	\$25,270	0.25	0.50	30% 30%	\$2,199	6.32	61
13	OLD HARDIN ROAD & CLAYTON	5	\$1,320	\$348	\$100	\$448	\$25,270	0.75	1.25	12% 13%	\$2,552	5.69	58
14	OLD BLUE CREEK ROAD	10	\$7,670	\$1,248	\$50	\$1,298	\$25,270	0.50	0.75	40% 27%	\$5,536	4.26	48
15	72ND STREET W. AT R.R. TRACKS	5	\$4,960	\$1,308	\$100	\$1,408	\$25,270	0.75	0.75	29% 20%	\$5,850	4.15	47
16	SHEPHERD RD. & SHEPHERD -ACTON	15	\$17,110	\$2,250	\$800	\$3,050	\$25,270	1.50	1.50	30% 30%	\$12,454	4.08	47
17	VALLEY DRIVE NEAR COVE DITCH	5	\$4,260	\$1,124	\$400	\$1,524	\$25,270	0.50	0.75	35% 27%	\$4,885	3.21	39
18	JELLISON ROAD CURVES	15	\$11,770	\$1,547	\$200	\$1,747	\$25,270	0.75	1.50	25% 25%	\$5,498	3.15	38
19	GARDEN AVE. N. OF SUGAR AVE.	10	\$6,920	\$1,126	\$100	\$1,226	\$25,270	0.25	1.50	40% 33%	\$3,426	2.79	34
20	HIGHWAY 312 & HUNTLEY TURNOUT	15	\$13,620	\$1,791	\$400	\$2,191	\$25,270	0.75	0.50	20% 40%	\$4,234	1.93	22
21	ROAD 15N NORTH OF HWY 312	5	\$5,100	\$1,345	\$300	\$1,645	\$25,270	0.25	1.00	40% 25%	\$3,015	1.83	20
22	COBURN ROAD & ROSEBUD LANE	10	\$10,400	\$1,693	\$500	\$2,193	\$25,270	0.00	1.00	30% 30%	\$494	0.23	0
TOTALS :			\$120,300	\$21,878	\$4,350	\$26,228					\$153,317		
AVERAGES :			7.3	\$5,468	\$994	\$198	\$1,192				\$6,968.95	8.32	60.1

COMPOUNDED INTEREST RATE :

10%

COST OF FATAL ACCIDENT :

\$240,000 (1986 NATIONAL SAFETY COUNCIL DATA)

COST OF INJURY ACCIDENT :

\$10,800

COST OF PROPERTY DAMAGE ACCIDENT ;

\$1,600

I/F RATIO PRIMARY :

17.2

I/F RATIO SECONDARY :

14.8

ADTa/ADTb :

1.03

VALUES FROM MOOH SAFETY SECTION

PRIORITY INDEX

The ranking of site improvement priorities cannot be directly dependent on the hazard ranking of the twenty sites. The value of the improvements must enter into the priority listing in the form of the benefit/cost ratio (B/C). The method of developing a composite Hazard Index - B/C listing must not be dependent on the number of locations studied. Therefore, a correlation of scale between the B/C ratio and hazard indicator value was developed on the following assumptions:

1. The contributing conditions creating hazards at each site and the resulting hazard ranking is relatively independent of the cost of correcting these conditions.

2. Benefits to be derived from the correcting hazardous situations at each site is indirectly proportional to the degree of hazardness.

3. The benefit-cost ratio, by virtue of benefit computation, is indirectly proportional to the number of accidents indicator and severity indicator, both of which are curvilinear functions.

4. The benefit-cost ratios can be rated on a scale of 0 to 100 based on a curvilinear function.

5. The B/C ratio of 1.0 is equivalent to an indicator value of 0 and the upper limit (indicator value = 100) must be chosen to encompass the majority of sites. In this case a B/C of 20.0 assumes the indicator value of 100.

Based on these assumptions a graphic plot of the B/C ratio versus B/C indicator value has been established and it is shown in Figure 9. Since it has been graphed on semi-log paper the line appears linear.

Since the relative weighting of benefit-costs and hazardness is a controversial subject which would require research beyond the scope of this report, it is felt that the priority index should be based on 33% weighting for the benefit-cost ratio and 67% weight on the hazard index. Therefore, to establish a priority index the following formula has been devised:

$$\text{Priority Index} = (\text{Hazard Index}) \times (0.67) \\ + (\text{Cost-Benefit Indicator}) \times (0.33)$$

Table 13. is the computer generated summary of priority ranking based on the composite hazard index - benefit/cost index values.

It should be noted that the priority list contains only short term improvements. Since all long term improvements were not practical based on future conditions of volume and use, no priority listing for long term improvements was assembled.

TABLE 13. SITE RANKING BY PRIORITY INDEX - CALCULATION SUMMARY

PRIORITY NUMBER	INTERSECTION LOCATION	HAZARD INDEX	WEIGHTED VALUE	BEN/COST INDEX	WEIGHTED VALUE	PRIORITY INDEX
1	CENTRAL AVENUE & 56TH STREET W.	66.24	44.38	100	33.00	77.38
2	BENCH BLVD. & TWO MOON PARK	70.93	47.52	84	27.72	75.24
3	CA ROAD N. OF SCANDIA ROAD	70.46	47.21	81	26.73	73.94
4	INDIAN CAVES ROAD	71.46	47.88	77	25.41	73.29
5	DRURY LANE & HOSKINS ROAD	55.43	37.14	100	33.00	70.14
6	72ND STREET W. & LAUREL AIRPORT RD	57.60	38.59	89	29.37	67.96
7	OLD BLUE CREEK ROAD	77.69	52.05	48	15.84	67.89
8	NEIBAUER ROAD & 48TH STREET W.	59.03	39.55	80	26.40	65.95
9	72ND STREET W. AT R.R. TRACKS	70.71	47.38	47	15.51	62.89
10	HIGHWAY 312 & SHEPHERD RD *	60.34	40.43	67	22.11	62.54
11	BLUE CREEK ROAD & PRYOR CREEK ROAD	44.44	29.77	93	30.69	60.46
12	HIGHWAY 312 & MCGIRL ROAD *	54.54	36.54	72	23.76	60.30
13	SHEPHERD RD. & SHEPHERD -ACTON *	63.14	42.30	47	15.51	57.81
14	GARDEN AVE. N. OF SUGAR AVE.	67.68	45.35	34	11.22	56.57
15	VALLEY DRIVE NEAR COVE DITCH	64.34	43.11	39	12.87	55.98
16	12 MILE ROAD & HOMER DAVIS ROAD *	49.62	33.25	65	21.45	54.70
17	NEIBAUER ROAD & 64TH STREET W.	50.41	33.77	61	20.13	53.90
18	OLD HARDIN ROAD & CLAYTON	51.43	34.46	58	19.14	53.60
19	JELLISON ROAD CURVES *	60.03	40.22	38	12.54	52.76
20	HIGHWAY 312 & HUNTLEY TURNOUT *	61.48	41.19	22	7.26	48.45
21	ROAD 15N NORTH OF HWY 312	52.67	35.29	20	6.60	41.89
22	COBURN ROAD & ROSEBUD LANE *	51.43	34.46	0	0.00	34.46
AVERAGE VALUES :		60.50	40.54	60.09	19.83	60.37
STANDARD DEVIATIONS :		8.56	5.73	26.79	8.84	10.63

PRIORITY INDEX = (HAZARD IND. x .67) + (BEN/COST IND. x .33)

* SIGNIFIES THOSE SITES CARRIED OVER FROM THE 1985 STUDY

IMPLEMENTATION

Within Table 14, the priority lists have been arranged in a manner that budget considerations can readily be applied in the decision to proceed with improvements. The priority ranking should be the major consideration in selecting which sites will be receiving funds first. The listing assumes that eligible project costs will be funded by the MDOH Off-System Safety funds. The MDOH funding limit is less than \$ 10,000 per project period, or else formal bid letting procedures would be required by MDOH. This figure is used as the criteria to define the construction groupings. The estimated costs not covered by MDOH funds are considered County funding requirements. If Yellowstone County performs this work, the actual costs would probably be much less.

There is no timetable given for these improvements. It may be conceivable that MDOH could fund more than one of the site groups in a single year depending on available funding. The County will want to request funding from MDOH by submitting this report to Robert Champion, P.E., Administrator, Project Development Coordinator.

TABLE 14 PROJECT IMPLEMENTATION GROUPINGS

PRIORITY NUMBER	L O C A T I O N	CONSTRUCT. COST ESTIMATE	M.D.O.H. ELIGIBLE FUNDS	COUNTY FUNDS
1	CENTRAL AVENUE & 56TH STREET W.	\$1,630.00	\$940.00	690.00
2	BENCH BLVD. & TWO MOON PARK	\$2,900.00	\$1,910.00	990.00
3	CA ROAD N. OF SCANDIA ROAD	\$2,420.00	\$2,260.00	160.00
4	INDIAN CAVES ROAD	\$3,320.00	\$3,320.00	0.00
5	DRURY LANE & HOSKINS ROAD	\$1,030.00	\$610.00	420.00
CONSTRUCTION GROUP #1 TOTALS =		\$11,300.00	\$9,040.00	\$2,260.00
6	72ND STREET W. & LAUREL AIRPORT RD	\$2,270.00	\$970.00	1300.00
7	OLD BLUE CREEK ROAD	\$7,670.00	\$4,870.00	2800.00
8	NEIBAUER ROAD & 48TH STREET W.	\$1,600.00	\$940.00	660.00
9	72ND STREET W. AT R.R. TRACKS	\$4,960.00	\$1,310.00	3650.00
10	HIGHWAY 312 & SHEPHERD RD *	\$7,160.00	\$1,860.00	5300.00
CONSTRUCTION GROUP #2 TOTALS =		\$23,660.00	\$9,950.00	\$13,710.00
11	BLUE CREEK ROAD & PRYOR ROAD	\$900.00	\$660.00	240.00
12	HIGHWAY 312 & McGIRL ROAD *	\$12,760.00	\$3,060.00	9700.00
13	SHEPHERD RD. & SHEPHERD -ACTON *	\$17,110.00	\$400.00	16710.00
14	GARDEN AVE. N. OF SUGAR AVE.	\$6,920.00	\$1,860.00	5060.00
15	VALLEY DRIVE NEAR COVE DITCH	\$4,260.00	\$1,640.00	2620.00
16	12 MILE ROAD & HOMER DAVIS ROAD *	\$240.00	\$0.00	240.00
17	NEIBAUER ROAD & 64TH STREET W.	\$940.00	\$660.00	280.00
18	OLD HARDIN ROAD & CLAYTON	\$1,320.00	\$750.00	570.00
CONSTRUCTION GROUP #3 TOTALS =		\$44,450.00	\$9,030.00	\$35,420.00
19	JELLISON ROAD CURVES *	\$11,770.00	\$680.00	11090.00
20	HIGHWAY 312 & HUNTLEY TURNOUT *	\$13,620.00	\$6,160.00	7460.00
21	ROAD 15N NORTH OF HWY 312	\$5,100.00	\$1,720.00	3380.00
CONSTRUCTION GROUP #4 TOTALS =		\$30,490.00	\$8,560.00	\$21,930.00

* SIGNIFIES THOSE SITES WHICH ARE CARRIED OVER FROM 1985 STUDY

PROGRAM CONTINUATION

Since the basic format of the study has been outlined and an initial priority list established, continuance of the program is strongly advised. The findings and recommendations of this study will soon become obsolete without continued updating at least on an annual basis.

The following recommendations in the continuance of the program are offered to Yellowstone County:

1. The Department of Justice should continue to be assessed for copies of accident reports.
2. One person should be assessed with the responsibility of the program to insure that all data is being supplied, processed and filed.
3. An accident cluster map should be maintained.
4. Criteria should be developed for the inclusion of additional sites to be analyzed.
5. Coordinate any traffic counting programs that may exist or establish a counting program.
6. Analyze new sites according to the procedures of this study and include them in the priority list when warranted.

All of the data processing and storage can be handled by the Lotus 123 software. If an IBM compatible computer is available for use by the county, a copy of the data disk has been provided.

1985 STUDY SITE IMPROVEMENTS

The following narratives briefly outline the study's findings on the seven 1985 sites that remain in the priority ranking of this study. Necessary improvements at the sites are outlined in Figures 10. at the end of this section. They are reproductions of original drawings in the original 1985 report.

HIGHWAY 312 - SHEPHERD ROAD

Originally ranked number 7 in the 1985 study, this intersection continued to experience the same type of accidents although the rate went down slightly. Virtual none of the improvements recommended were made. Revised construction costs for the improvements are \$ 7,160.00.

HIGHWAY 312 - MCGIRL ROAD

This intersection was ranked number 14 in 1985. A similar number of and type of accidents occurred in the new analysis period. None of the recommended improvements were made at this site. The improvements shown in Figure 10. still apply and a cost of \$12,760.00 is estimated.

SHEPHERD ROAD - SHEPHERD ACTON ROAD

Ranking number 8 in 1985, all of the signing recommendations were made. However, the pavement markings were not revised, sight distances have deteriorated and the pedestrian paths were not constructed. The accident rate has remained the same but the type of accidents have changed. Since the signing was only part of the required improvements, the other recommendations should be implemented at an estimated cost of \$17,110.00.

MILE ROAD - HOMER DAVIS ROAD

The accident rate remained the same at this intersection which was ranked number 5 in 1985. Signing improvements were made but none of the pavement markings were completed. The angle accidents at the intersection were eliminated and replaced with single vehicle accidents. The cost of finishing the improvements is \$240.00.

JELLISON ROAD CURVES

At a ranking of number 11 in 1985, Jellison Road had a history of side swipe and head-on accidents due to sharp curves and a narrow roadway. Most of the signing improvements were implemented but the accident rate increased. Sideswipe accidents continued primarily because the roadway curve widening was not completed. Also, positioning of delineation on the curves was not aligned correctly. Costs associated with completing the improvements is estimated at \$ 13,950.00.

HIGHWAY 312 - HUNTLEY APPROACH

None of the improvements recommended in 1985 were made at this location. Ranked number 19 out of 20 sites, the accident rate has reduced slightly and the same type of accidents continue. Estimated cost to complete improvements is \$13,620.00.

COBURN ROAD - ROSEBUD LANE

Ranked number 17 in 1985, a significant reduction in accidents has occurred. Most of the signing recommendations were implemented but none of the physical improvements were made. Cost of finishing the improvements is estimated at \$ 10,400.00. The benefit/cost ratio is less than 1.0 at this site and therefore, no additional project should be planned at this location. However, the site should be monitored and access changes made whenever the opportunity presents itself.

REPORT

FIGURES

FIGURE 1

SITE LOCATION

MAPS

LEGEND

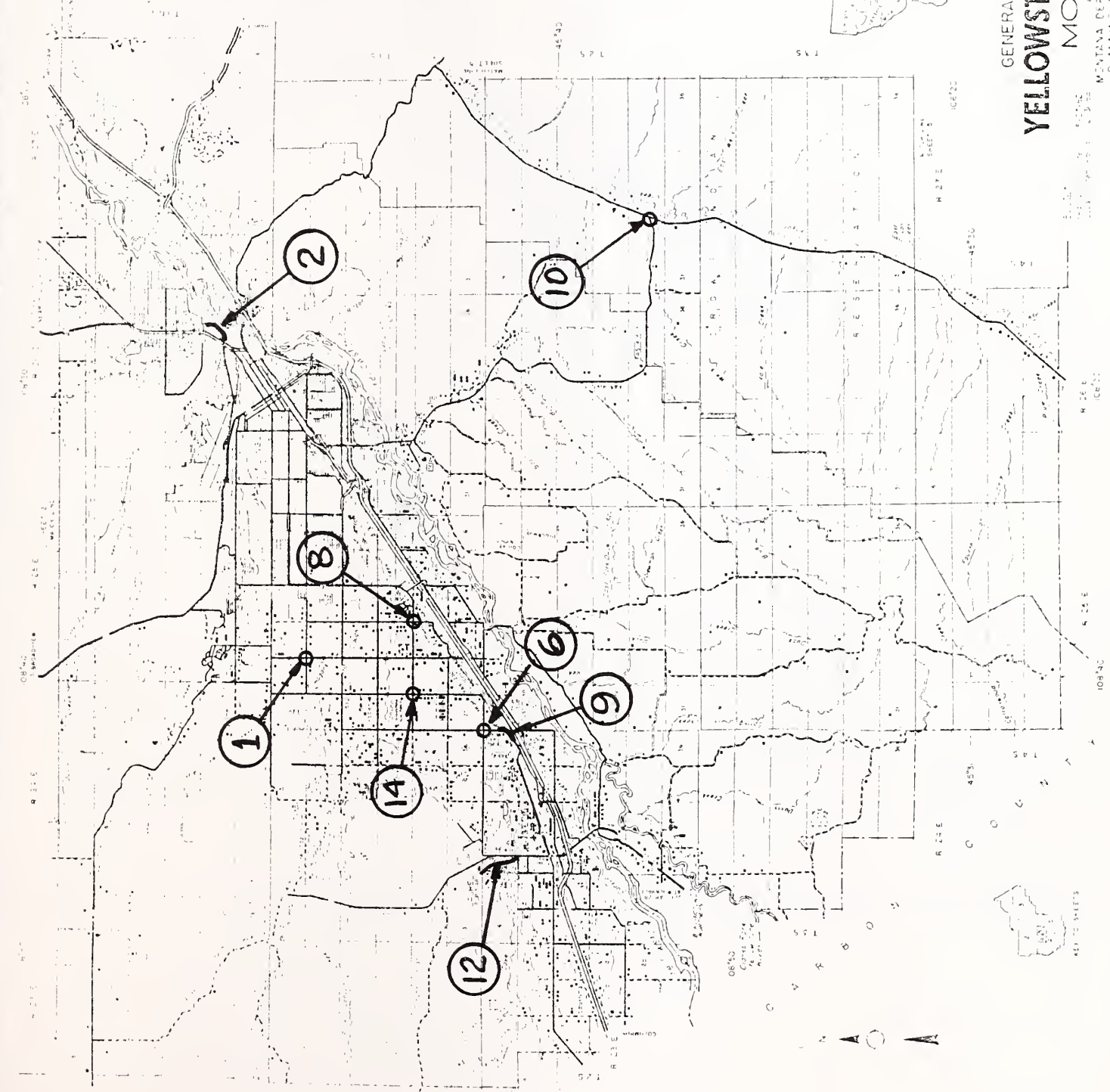


Section 1, Township 14N, Range 10E, Yellowstone County, Montana. This map shows the general highway network for the area. The map is divided into sections, with the following sections shown: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. The map also shows the following features: 1. Roads: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. 2. Rivers: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. 3. Terrain: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.



GENERAL HIGHWAY MAP YELLOWSTONE COUNTY MONTANA

PREPARED BY THE
MONTANA DEPARTMENT OF HIGHWAY
PLANNING AND RESEARCH BUREAU
J.S. DEARMON, CHIEF
FEDERAL HIGHWAY ADMINISTRATION



S I G N E D C O U N T Y


$$\vec{u} = \vec{v} - \vec{v}_0 \quad \vec{v} = \vec{v}_0 + \vec{u}$$
[illegible]

10
 11
 12
 13
 14

1

[illegible]

1. DATE 11/11/68
 2. TO Mr. [redacted]
 3. FROM Mr. [redacted]
 4. SUBJECT [redacted]
 5. RE [redacted]
 6. REFERENCE [redacted]
 7. ACTION [redacted]
 8. STATUS [redacted]
 9. COMMENTS [redacted]
 10. APPROVED [redacted]
 11. SIGNED [redacted]
 12. DATE [redacted]

[illegible][illegible]

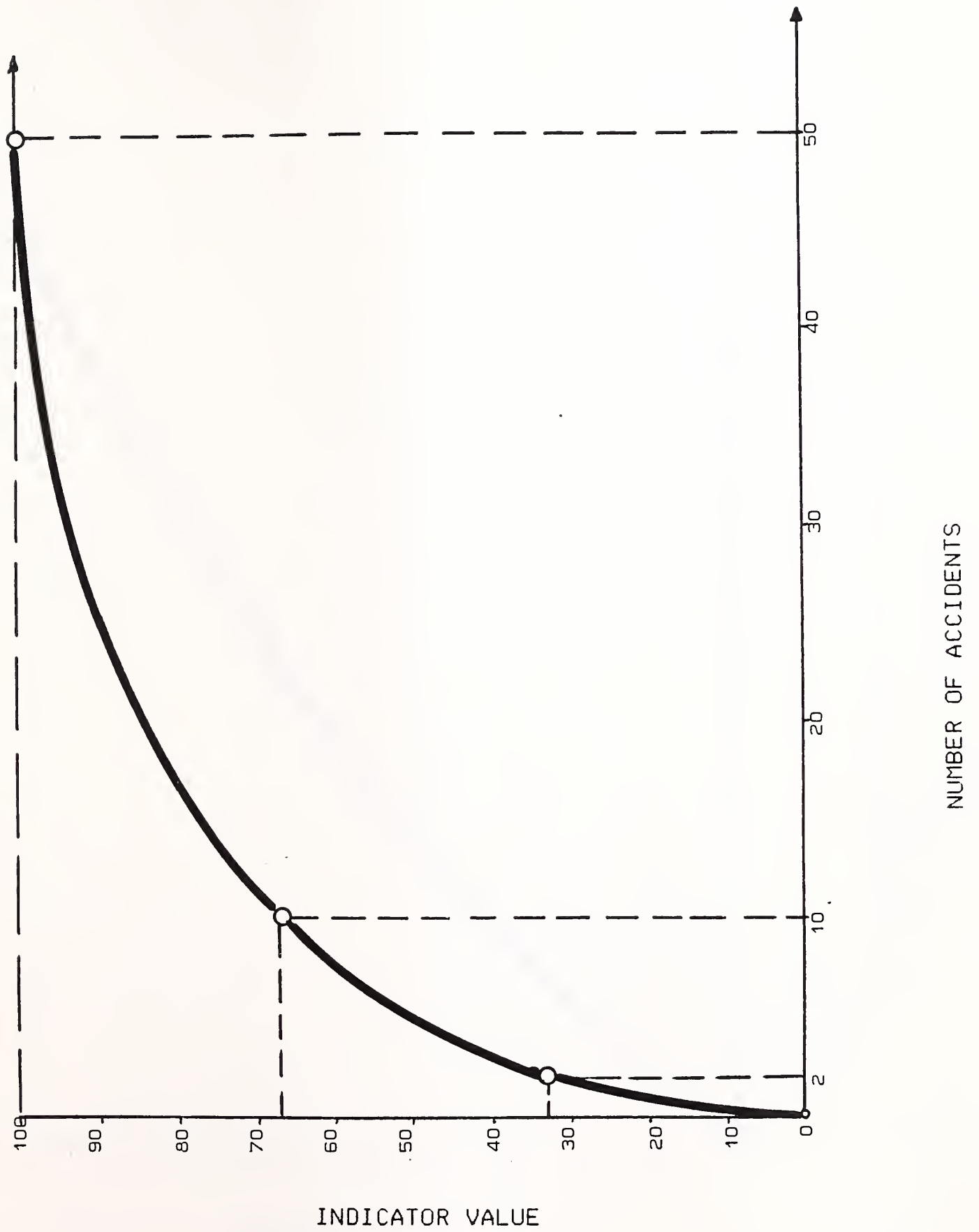


FIGURE 2. NUMBER OF ACCIDENTS INDICATOR

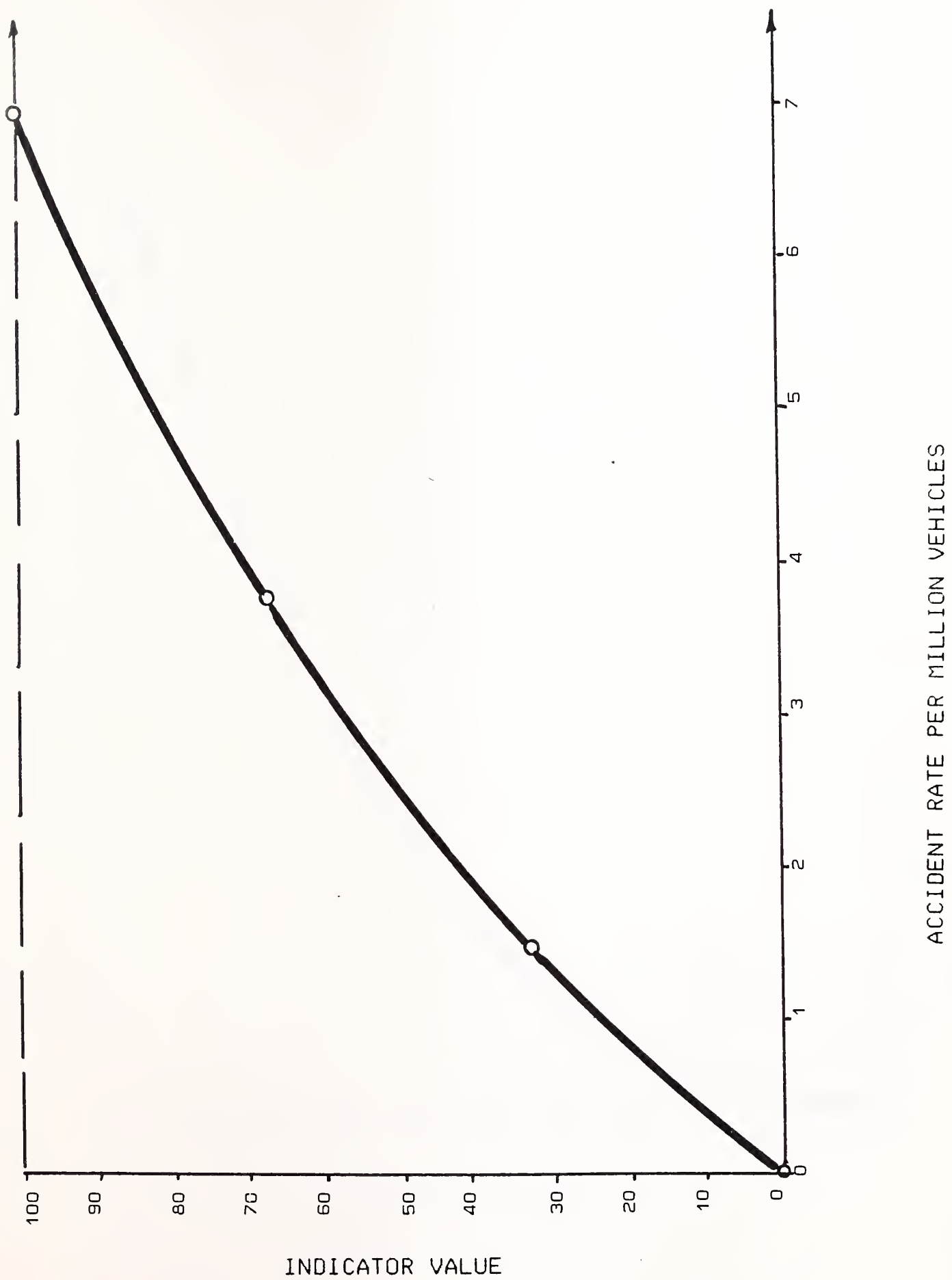


FIGURE 3. ACCIDENT RATE INDICATOR

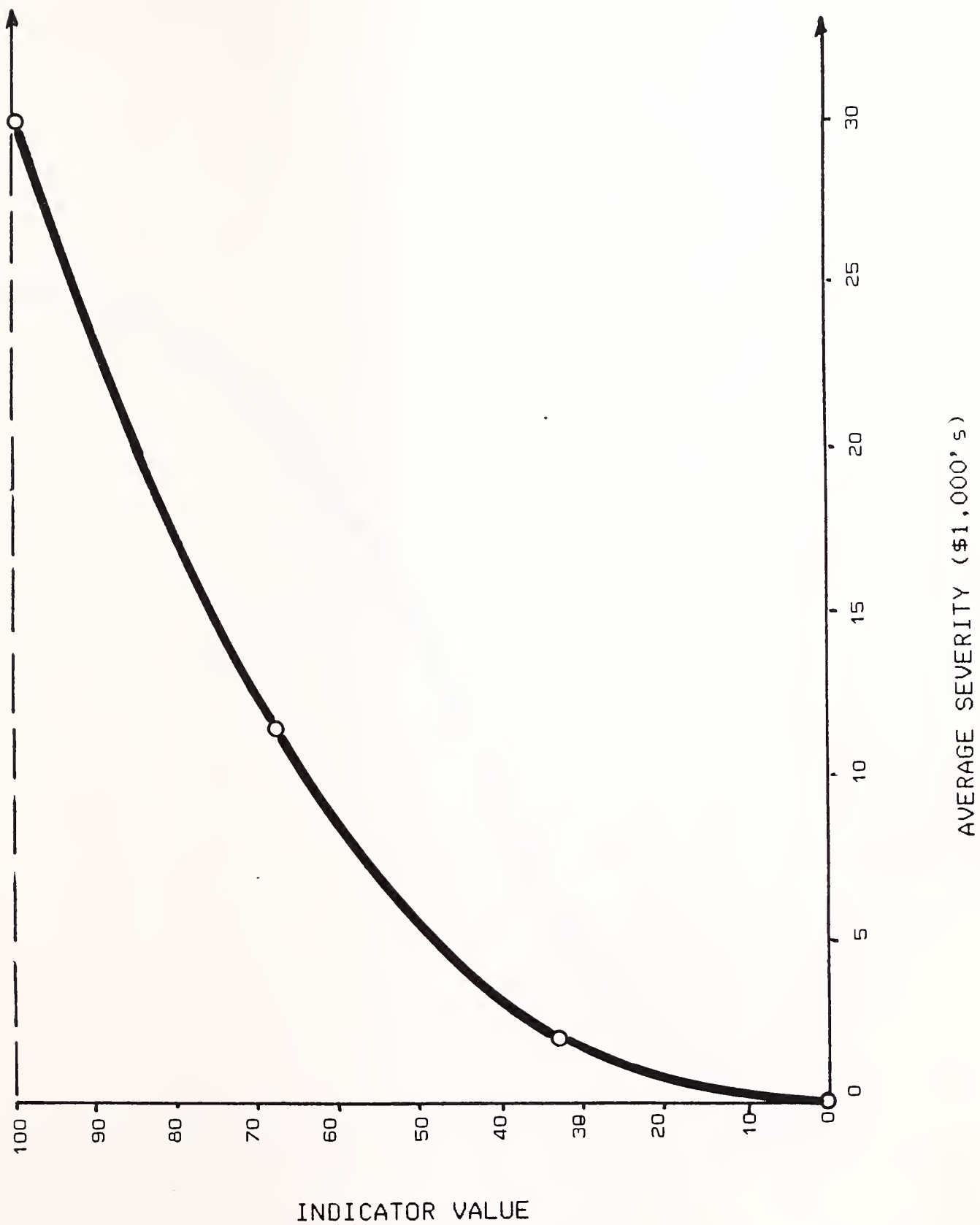


FIGURE 4. ACCIDENT SEVERITY INDICATOR

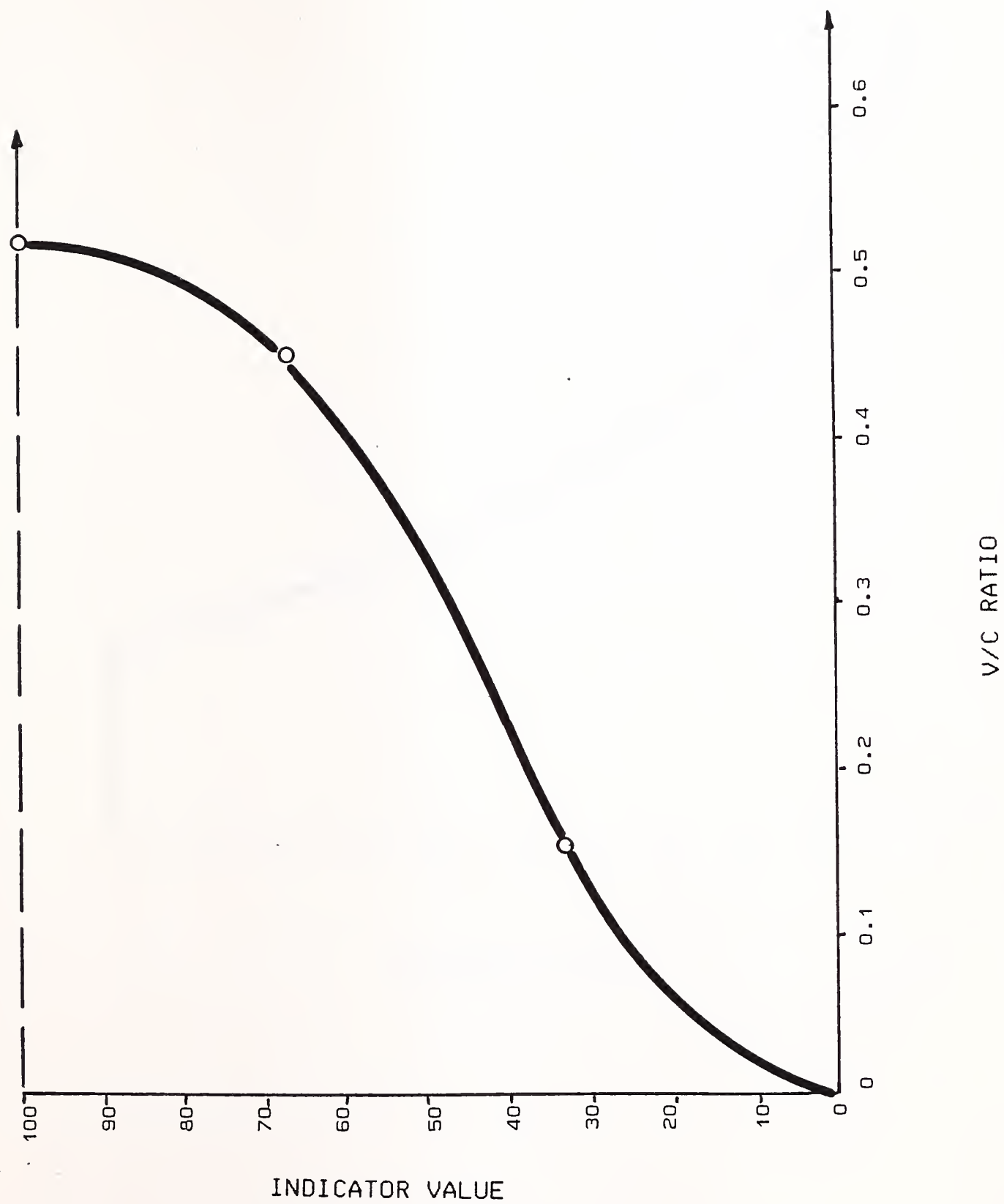


FIGURE 5. V/C RATIO INDICATOR

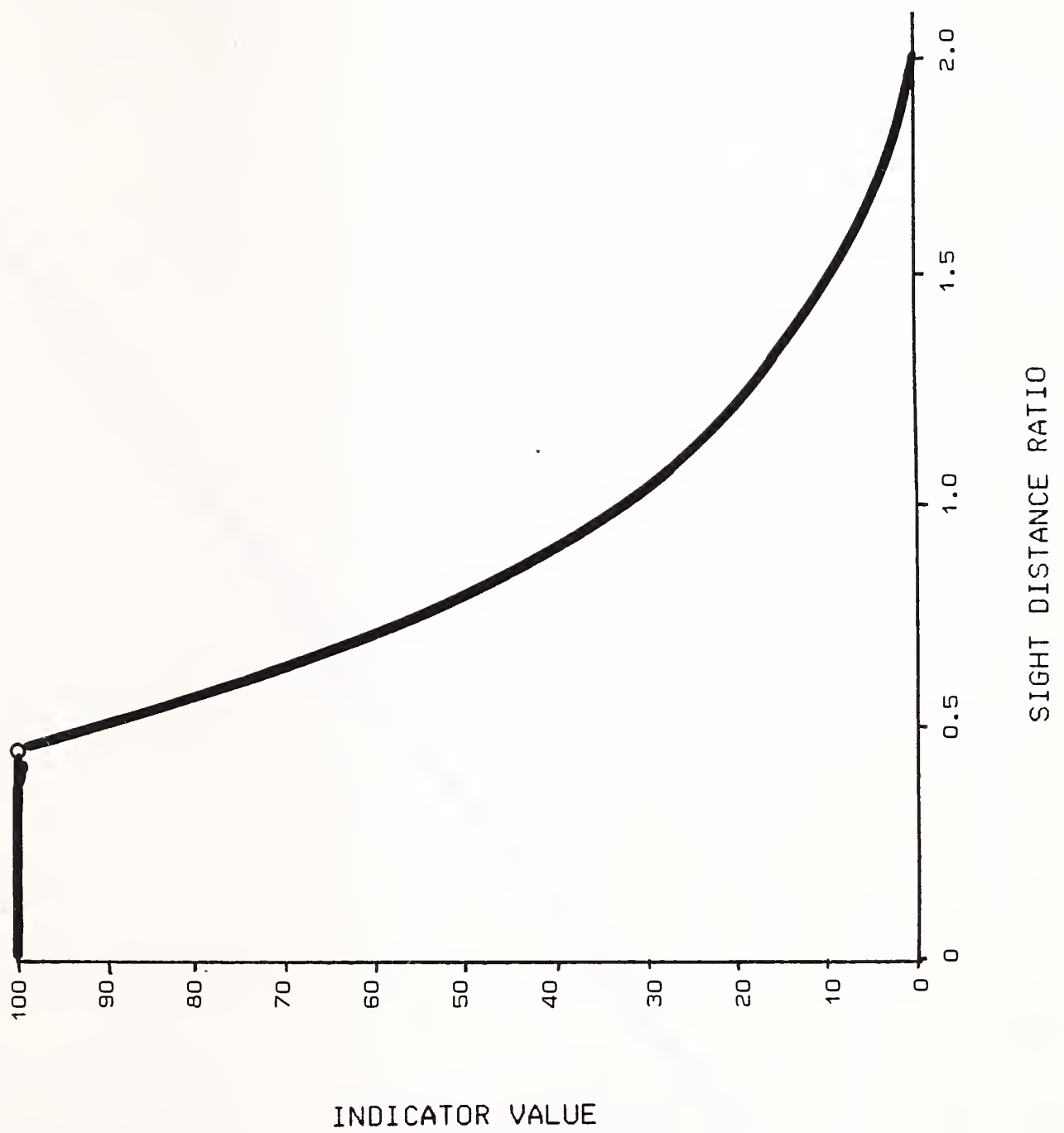


FIGURE 6. SIGHT DISTANCE INDICATOR

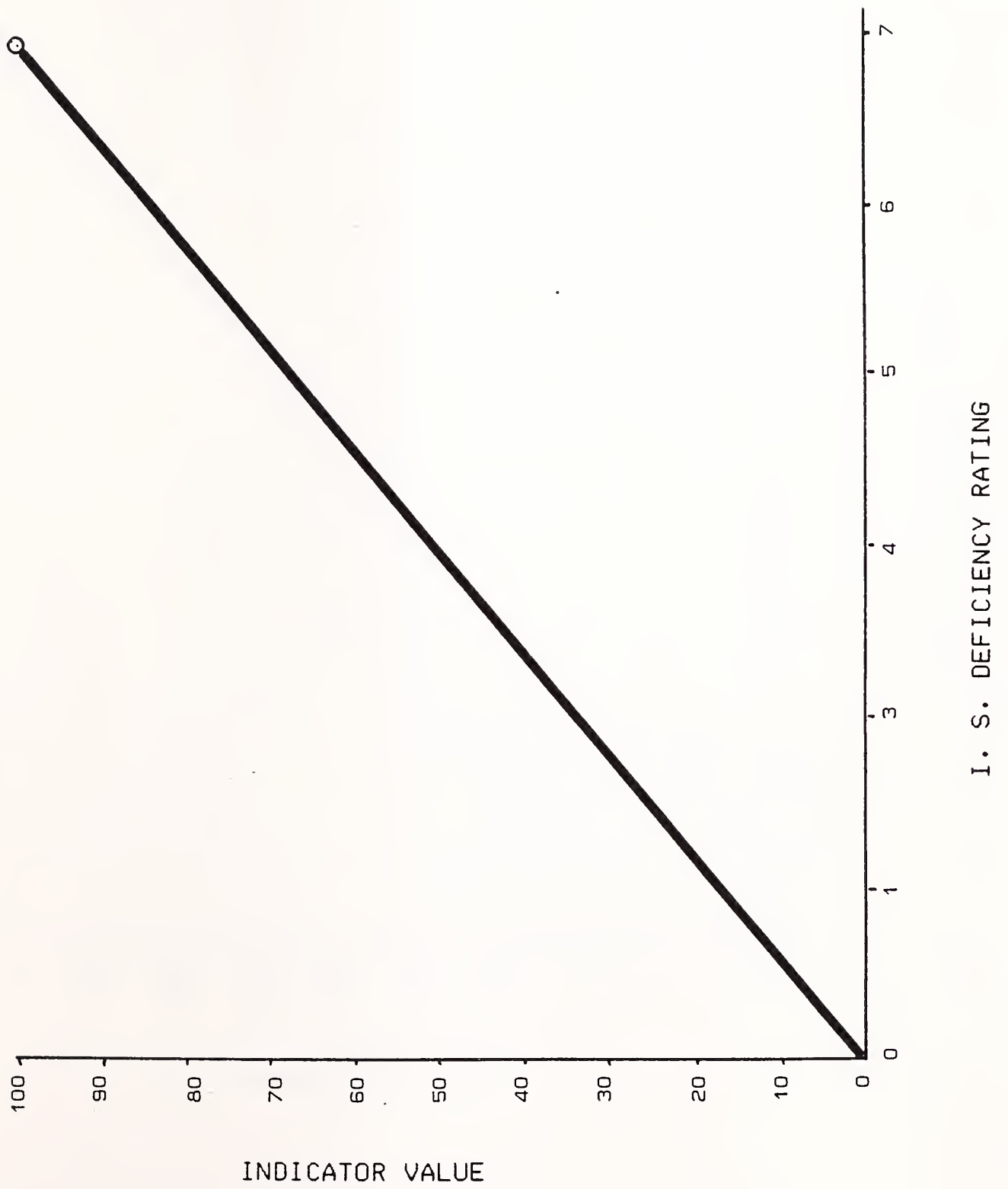


FIGURE 7. INFORMATION DEFICIENCY INDICATOR

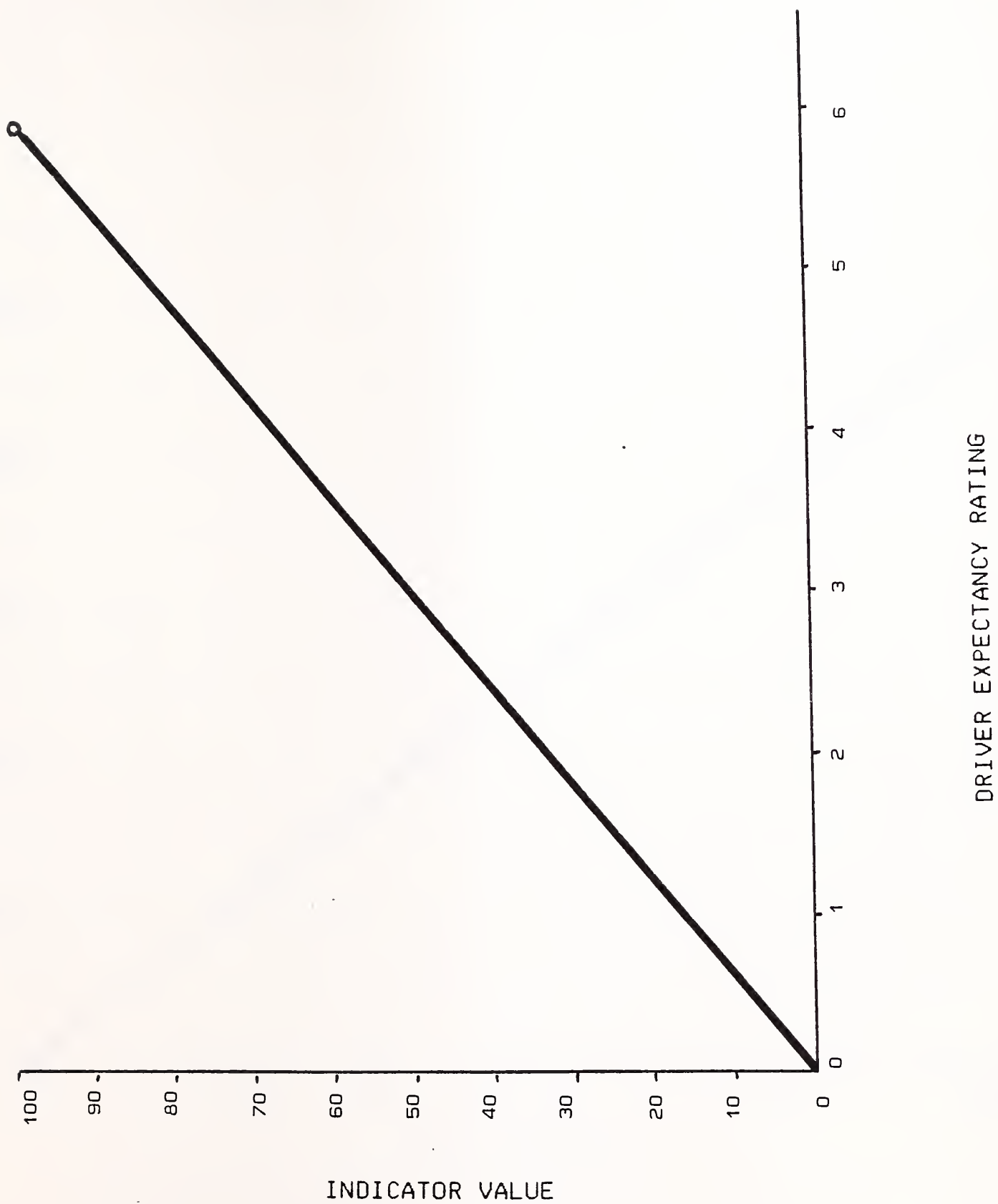


FIGURE 8. DRIVER EXPECTANCY INDICATOR

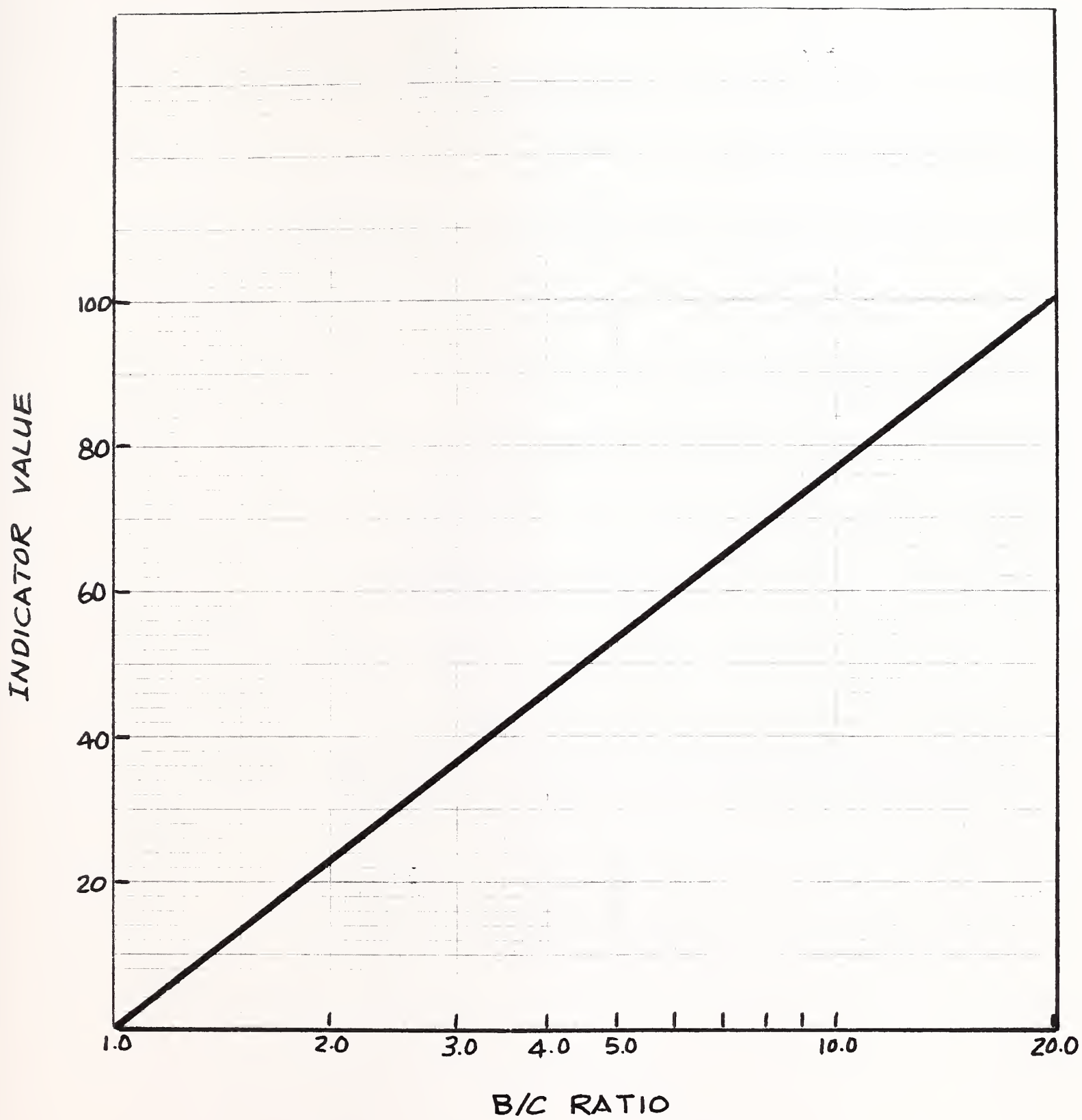


FIGURE 9. BENEFIT/COST RATIO

FIGURE 10.

1985 STUDY SITE IMPROVEMENTS

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - MCGIRL ROAD

ACCIDENT TYPE

ACCIDENT TYPE	1/F	PD	CHANGE	EST. \$	CHANGE IN # ACC.
HEAD ON	1	0	-30.0%	-0.2	0.0
ANGLE	0	3	-80.0%	0.0	-2.4
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	1	-50.0%	0.0	-0.5
REAR END	1	2	-50.0%	-0.5	-1.0
SINGLE VEHICLE	1	0	-30.0%	-0.3	0.0
PEDESTRIAN	1	0	-10.0%	-0.1	0.0
OTHER	0	2	-30.0%	0.0	-0.6
TOTALS :	4	8	***	-1.1	-4.5

\$ REDUCTION IN INJURY/FATAL ACCIDENTS = -27.5%

\$ REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -54.3%

NEW 36"x36" 700' FROM INTERSECTION

PLACE ON YELLOW

NEW 700' FROM INTERSECTION

SCALE: 1"=100'

LARIMER RD

NEW STREET NAME

NEW STREET NAME

NEW 36"x36" 700' FROM INTERSECTION

MODIFY APPROACH

DEAD END

36"x36"

CLINE RD

NEW FINING (TYP)

STOP

NEW 36"x36" 700' FROM INTERSECTION

REMOVE 36"x36" 700' FROM INTERSECTION

REMOVE 36"x36" 700' FROM INTERSECTION

REMOVE 36"x36" 700' FROM INTERSECTION

REMOVE 36"x36" 700' FROM INTERSECTION

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REMOVE 36"x36" 700' FROM INTERSECTION

REMOVE 36"x36" 700' FROM INTERSECTION

HIGHWAY 312 - MCGIRL ROAD

IMPROVEMENT COST ESTIMATE 1988 UPDATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL COST
1	NEW SIGNS (6' x 6' SF)	2	Ea	\$100.00	\$200.00
2	NEW SIGNS (6' x 6' SF)	15	Ea	\$140.00	\$2,100.00
3	NEW SUPPLEMENTARY SIGNS	4	Ea	\$20.00	\$80.00
4	RETRIEVE SIGNS	4	Ea	\$20.00	\$80.00
5	RETRIEVE SIGNS	4	Ea	\$20.00	\$80.00
6	PAVE MARKINGS (PAINT)	10	Gal	\$30.00	\$300.00
7	PAVE MARKINGS (PLASTIC)	180	SF	\$6.00	\$1,080.00
8	DELINEATORS, FLEXIBLE	28	Ea	\$20.00	\$560.00
9	TRIM TREES	1	LS	\$200.00	\$200.00
10	RECONSTRUCTION	1	LS	\$8,000.00	\$8,000.00
TOTAL CONSTRUCTION COSTS					\$12,760.00

TOTAL CONSTRUCTION COSTS

MARVIN & ASSOCIATES
304 S. 1st St.
P.O. Box 107
Yellowstone, WY 82401
Traffic Engineering & Cost Engineering

TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY ROADS

Hwy. 312 & MCGIRL RD.
SHORT TERM IMPROVEMENTS

Project No. _____
Sheet No. _____
Date _____
Drawn By _____
Checked By _____
Reviewed By _____

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : 12 MILE ROAD - HOMER DAVIS ROAD				
ACCIDENT TYPE	# ACC. IN PERIOD		CHANGE IN # ACC.	
	1/F	P/D	EST. %	1/F
HEAD ON	0	0	0%	0.0
ANGLE	0	2	-50%	0.0
LEFT TURN	0	0	0%	0.0
SIDE SWIPE	0	0	0%	0.0
REAR END	0	0	0%	0.0
SINGLE VEHICLE	0	0	0%	0.0
PEDESTRIAN	0	0	0%	0.0
OTHER	1	0	-25%	-0.3
TOTALS :	2	2	***	-0.8
REDUCTION IN INJURY/FATAL ACCIDENTS :				-37.5%
REDUCTION IN PROPERTY DAMAGE ACCIDENTS :				-50.0%

BLACK ON YELLOW



NEW 700' FROM INTERSECTION

TRIM LOWER BRANCHES

B.W. CAVAL

300'



RELOCATE TO A POINT 700' FROM INTERSECTION

REMOVE NEW 30"x36"

NORTH

SCALE: 1"=100'



24"x30"

REMOVE NEW 30"x36"



30"x30"

CONTROL PARKING ON R/W



30"x30"

RELOCATE TO A POINT 700' FROM INTERSECTION

HOMER DAVIS RD

RESTRIPE STD INTERSECTION APPROACHES

12 MILE RD



NEW 700' FROM INTERSECTION



BLACK ON YELLOW

12 MILE ROAD & HOMER DAVIS ROAD

IMPROVEMENT COST ESTIMATE 1988 UPDATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL COST
1	NEW SIGN (6.1 TO 10 SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGN (6.1 TO 10 SF)	0	Ea	\$140.00	\$0.00
3	NEW SUPPLEMENTARY SIGNS	0	Ea	\$50.00	\$0.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	0	Ea	\$20.00	\$0.00
6	PAVE MARKINGS (PAINT)	8	Gal	\$30.00	\$240.00
7	PAVE MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINCATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	0	LS	\$0.00	\$0.00
10	WIDEN CURVE	0	LS	\$0.00	\$0.00
TOTAL CONSTRUCTION COSTS =					\$240.00

M MARVIN & ASSOCIATES
404 N. 31st
BILLINGS MT 59107
Traffic Transportation & Civil Engineers Ph (406) 245-0088

TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY ROADS

12 MILE RD & HOMER DAVIS RD
SHORT TERM IMPROVEMENTS

Project No. _____
Sheet No. _____
Revision _____
Date _____
Drawn By _____
Checked By _____
Date _____

SHORT TERM IMPROVEMENTS

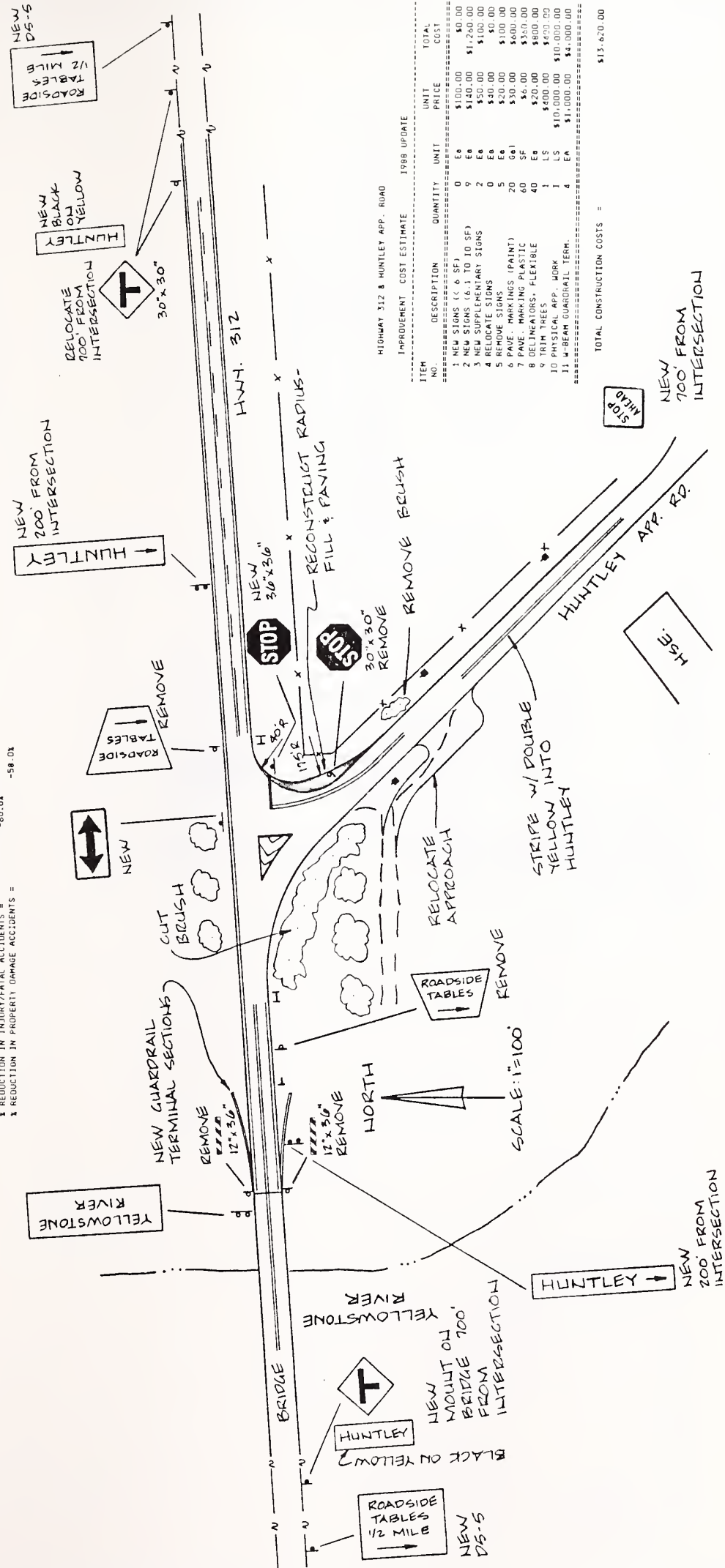
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - HUNTLEY APPROACH ROAD

ACCIDENT TYPE	1/F	PD	CHANGE IN # ACC.
HEAD ON	0	1	-50%
ANGLE	0	0	0.0
LEFT TURN	0	0	0.0
RIGHT TURN	0	0	0.0
SIDE SWIPE	0	0	0.0
REAR END	0	0	0.0
SINGLE VEHICLE	1	2	-60%
PEDESTRIAN	0	0	-1.2
OTHER	0	2	-60%
TOTALS :	1	5	-60.0%

REDUCTION IN INJURY/FATAL ACCIDENTS = -60.0%

REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -58.0%



HIGHWAY 312 & HUNTLEY APP. ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL COST
1	NEW SIGNS (< 6 SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGNS (6.1 TO 10 SF)	9	Ea	\$140.00	\$1,260.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	\$50.00	\$100.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	PAVE MARKINGS (PAINT)	5	Ea	\$20.00	\$100.00
6	PAVE MARKINGS (PLASTIC)	20	Ea	\$50.00	\$1,000.00
7	PAVE MARKINGS (FLEXIBLE)	40	Ea	\$75.00	\$3,000.00
8	CELINEATORS	40	Ea	\$25.00	\$1,000.00
9	TRIM TREES	1	LS	\$10,000.00	\$10,000.00
10	PHYSICAL APP. WORK	1	LS	\$10,000.00	\$10,000.00
11	W-BEAM GUARDRAIL TERM.	4	Ea	\$1,000.00	\$4,000.00
					\$13,670.00

TOTAL CONSTRUCTION COSTS =

\$13,670.00

COBURN ROAD & ROSEBUD LANE

IMPROVEMENT COST ESTIMATE 1998 UPDATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL COST
1	NEW SIGNS (6 6 SF)	6	EA	\$100.00	\$600.00
2	NEW TRIM TREES (10 SF)	0	EA	\$140.00	\$0.00
3	NEW SUPPLEMENTARY SIGNS	0	EA	\$50.00	\$0.00
4	RELOCATE SIGNS	0	EA	\$50.00	\$0.00
5	REMOVE SIGNS	0	EA	\$50.00	\$0.00
6	PAVE MARKINGS (PAINT)	8	GA	\$30.00	\$240.00
7	PAVE MARKINGS (PLASTIC)	40	SF	\$5.00	\$200.00
8	DELIMITATORS, FLEXIBLE	0	EA	\$200.00	\$0.00
9	TRIM TREES	1	LS	\$9,000.00	\$9,000.00
10	PHYSICAL APP. WORK	1	LS	\$200.00	\$200.00
TOTAL CONSTRUCTION COSTS =					\$10,400.00

NORTH

SCALE: 1"=100'

NEW

RESTRIPE w/ DOUBLE SOLID YELLOW & 4" WHITE FOG LINES
NEW PAW DOWN CURB (TYP)

OLD HARDIN RD.

NEW

GAS PUMPS

RESTRIPE w/ DOUBLE SOLID YELLOW & 4" WHITE FOG LINES

ROSEBUD LN.

WIDEN PAVE. 4' ON SOUTH SIDE OF ROAD

24" X 24" STOP SIGN REMOVE & NEW 30" X 30" W/ST. SIGNS

RELOCATE LIGHT POLE & PAIR POLE

CUT TREES & BRUSH

NEW 700' FROM INTERSECTION

NEW 600' FROM INTERSECTION

15

LIMITED SIGHT DISTANCE

NEW 700' FROM INTERSECTION

NEW 600' FROM INTERSECTION

STOP AHEAD

STOP

STOP

STOP

STOP

STOP

STOP

SHORT TERM IMPROVEMENTS				
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE				
SITE LOCATION: COBURN ROAD - ROSEBUD LANE				
ACCIDENT TYPE	ACC. IN PERIOD	EST. %	CHANGE IN # ACC.	PO
HEAD ON	0	0.0%	0.0	0.0
ANGLE	0	0.0%	0.0	0.0
LEFT TURN	0	0.0%	0.0	0.0
RIGHT TURN	0	0.0%	0.0	0.0
SIDE SWIPE	0	0.0%	0.0	0.0
REAR END	0	0.0%	0.0	0.0
SINGLE VEHICLE	0	0.0%	0.0	0.0
PEDESTRIAN	0	0.0%	0.0	0.0
OTHER	0	0.0%	0.0	0.0
TOTALS	0	0.0%	0.0	0.0
REDUCTION IN INJURY/FATAL ACCIDENTS =				-60.0%
REDUCTION IN PROPERTY DAMAGE ACCIDENTS =				-66.7%

TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY ROADS

COBURN RD. & ROSEBUD LN.
SHORT TERM IMPROVEMENTS

Submitted By: _____
Checked By: _____
Date: _____

Project No. _____
Client No. _____
Sheet No. _____

SITE ANALYSIS

SECTION

S
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B
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R

1

CENTRAL AVENUE & 56TH STREET W

PRIORITY NUMBER 1

SITE DESCRIPTION

Central Avenue is a Principal Arterial extending from 6th Street W. in Billings west to an intersection with 64th Street West. The section between 6th Street W. and 29th Street West is in the urban area and carries four lanes of traffic. West of 29th Street West, it is a two lane facility which accommodates residential subdivision traffic, traffic accessing commercial property and predominantly farm traffic near 56th Street West.

Fifty-sixth Street W. is classified as an arterial rural road. It extends from the north at Grand Avenue to a point south of South Frontage Road.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the intersection are less than 1% on all legs.

The property in the northeast quadrant of the intersection is a corn field that restricts sight distance at certain times of the year.

Traffic Control Devices. Pavement markings at this site were striped during the county-wide striping program in 1986. Existing stripes are readily apparent but not consistent with M.U.T.C.D. An overlay on the west approach has not been restriped. Fog lines are not present on either roadway.

No signing other than stop signs with street name signs exist at or in advance of the intersection.

Traffic Volumes. Peak hour counts were taken during the evening peak (4-5 PM). By applying the appropriate factors, it was determined that the average daily traffic is approximately 350 on 56th and 650 on Central Avenue.

Traffic Operations. It is apparent that the intersection violates driver expectancy and deficient information is provided. The physical features of the intersection are not visible until the vehicle is at the site which leaves no time to react. This deficiency exists for all approaches, but especially on the southbound approach.

Accidents. There were no reported accidents in 1984 or 1985. In 1986 there was 1 accident while the remaining 6 accidents occurred in 1987. The predominant accident involved the southbound movement. Drivers apparently fail to react to the stop condition and an angle accident occurred. The severity of these accidents is high with 86% of the accidents being injury accidents. These accidents occurred on dry roads at night which supports the observation that insufficient information is provided to drivers.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new stop ahead sign and replacement of the existing stop sign should greatly aid in improving the southbound accident problem. As additional reinforcement, it is recommended that the striping be modified at the intersection.

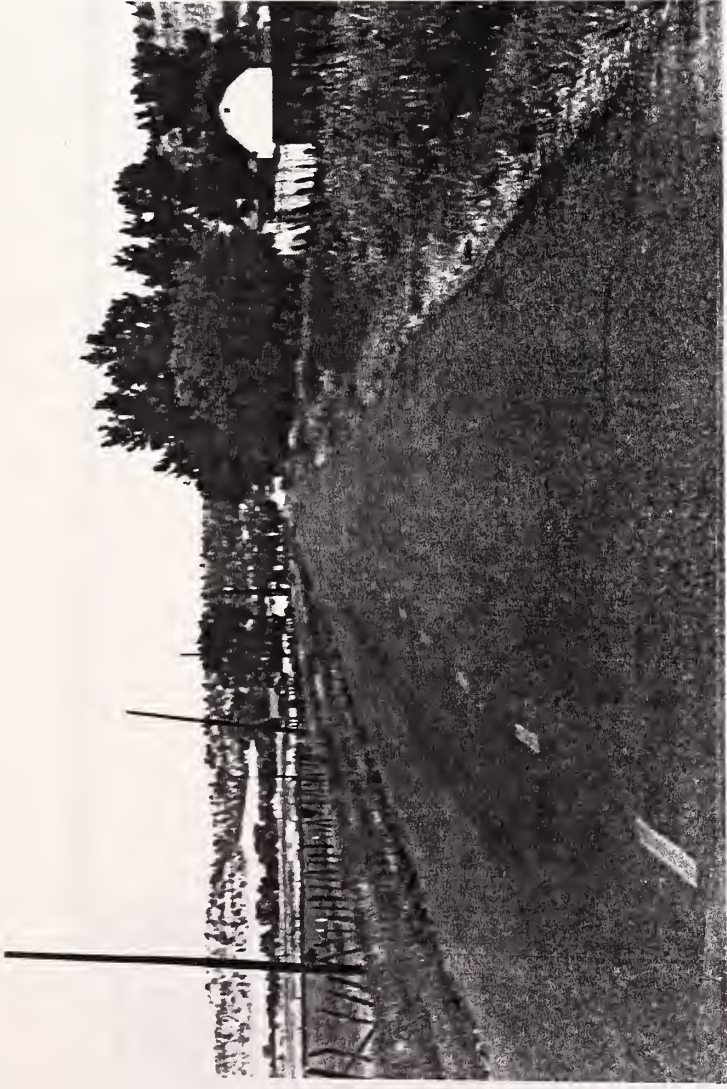
To improve information deficiencies on Central, new intersection warning signs with the supplementary name plates should be located 750 feet from the intersection on both approaches.

The estimated cost of these improvements is \$1,630.00 based on 1988 unit bid contract prices.

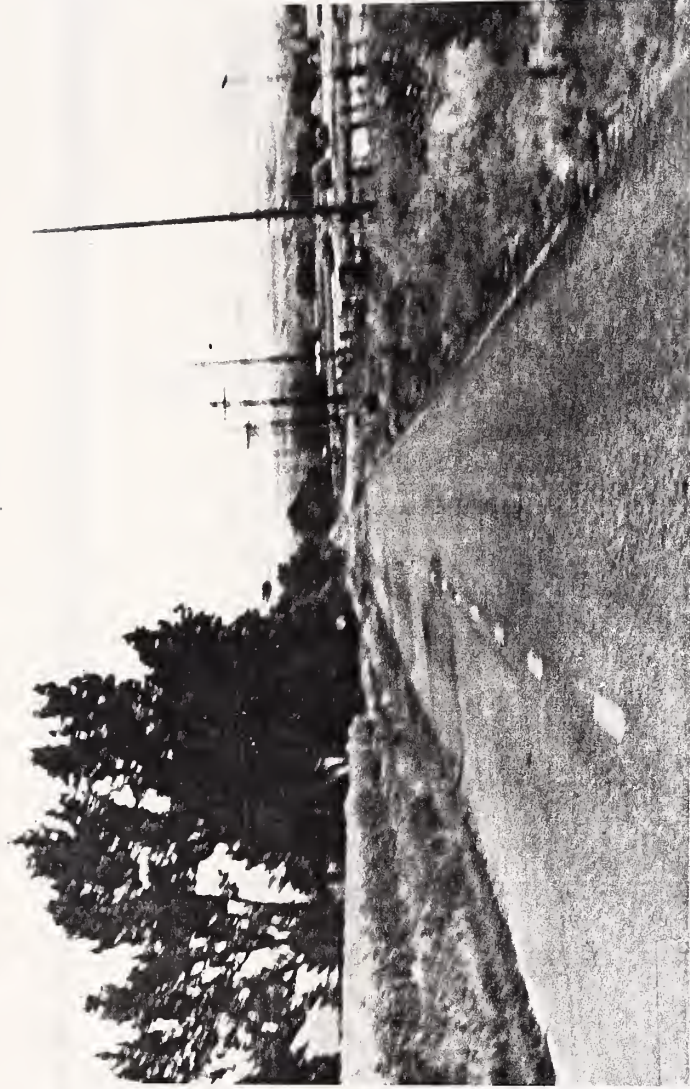
Long term improvements cannot be suggested at this point, since the degree of future traffic growth and the construction of alternate access facilities cannot be predicted with any certainty. It is assumed that volumes will not reach a critical stage within the next 20 years.

BENEFITS

By improving driver expectancy, the single vehicle accident rate is expected to be reduced. The net benefit, according to stated methods, would be approximately \$ 11,795 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 22.25.



CENTRAL & 56TH STREET WEST - NORTHBOUND



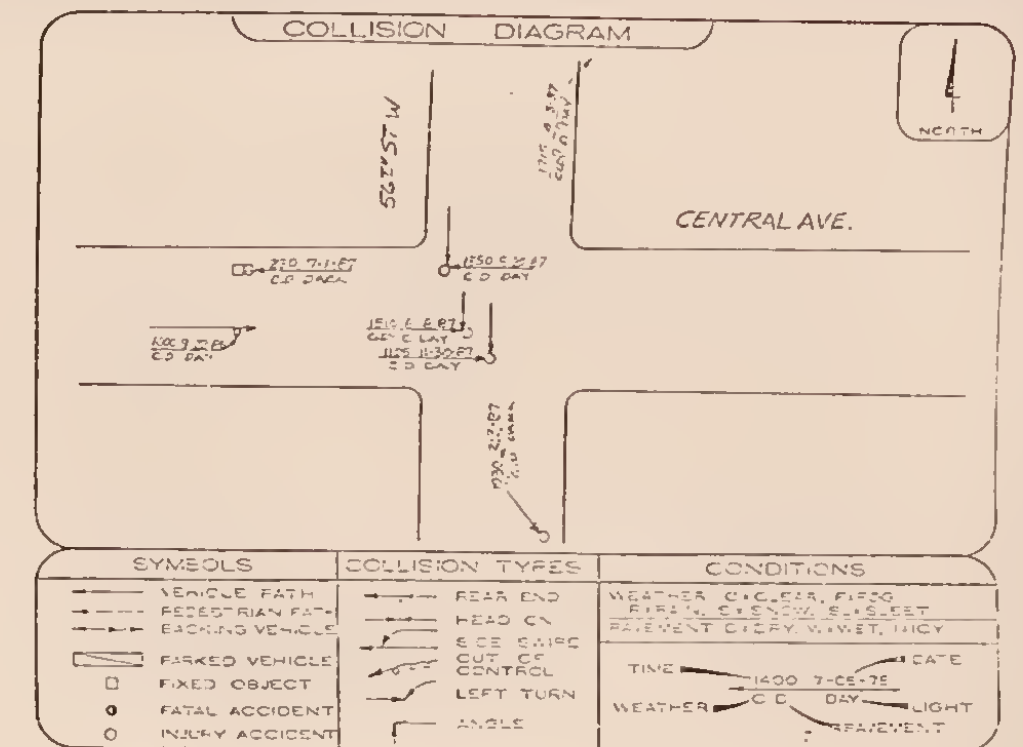
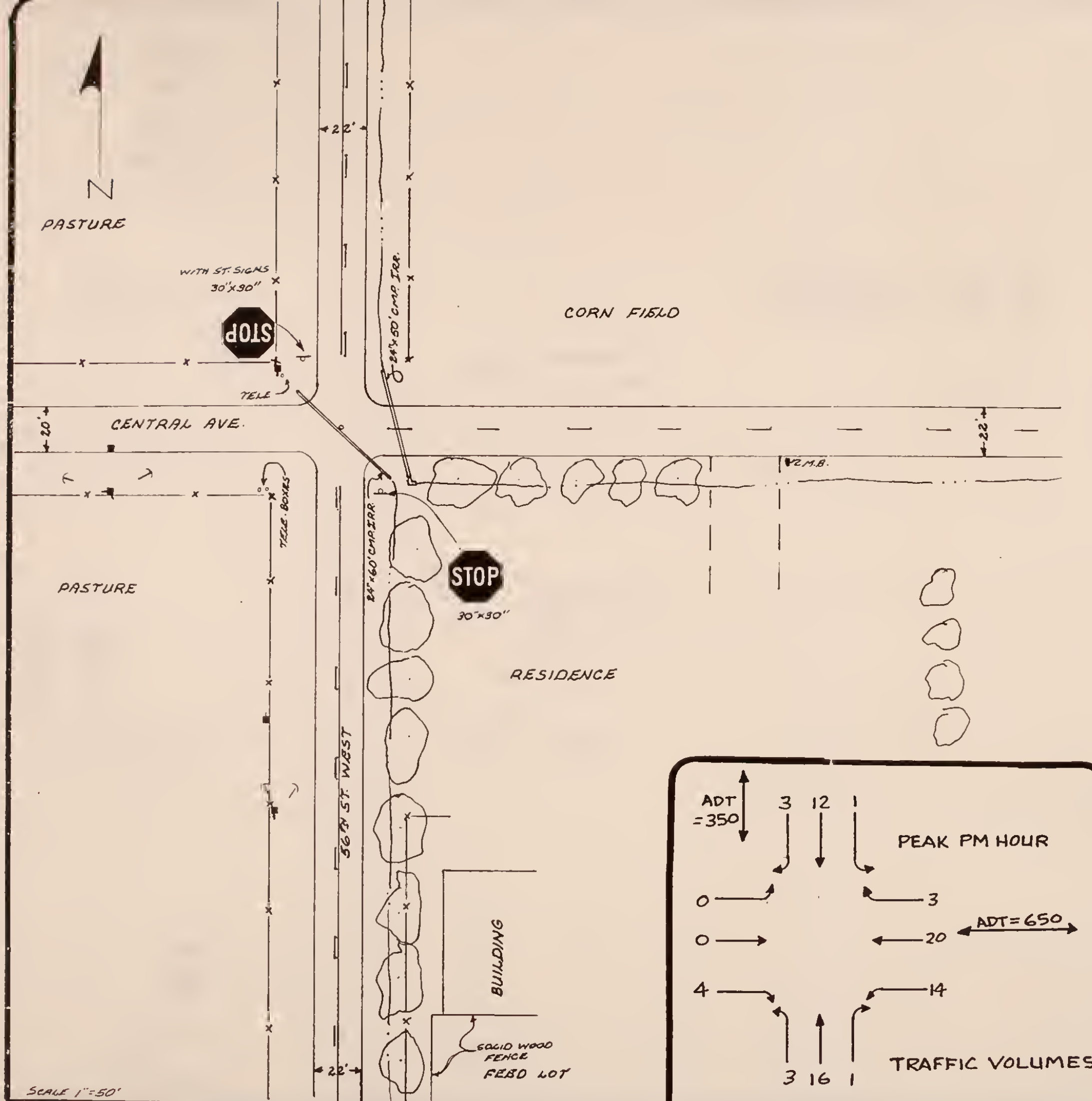
CENTRAL & 56TH STREET WEST - SOUTHBOUND



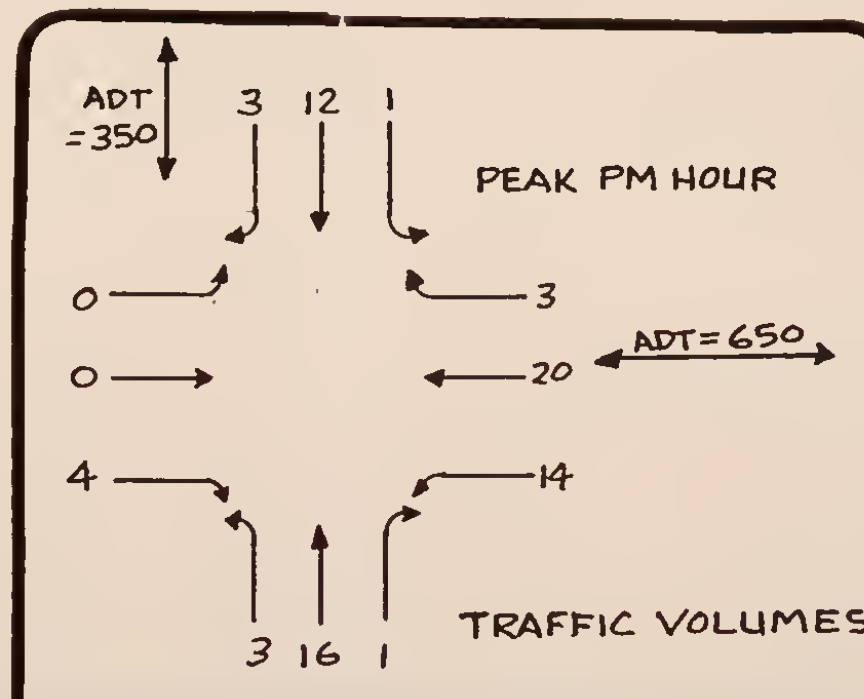
CENTRAL & 56TH STREET WEST - EASTBOUND

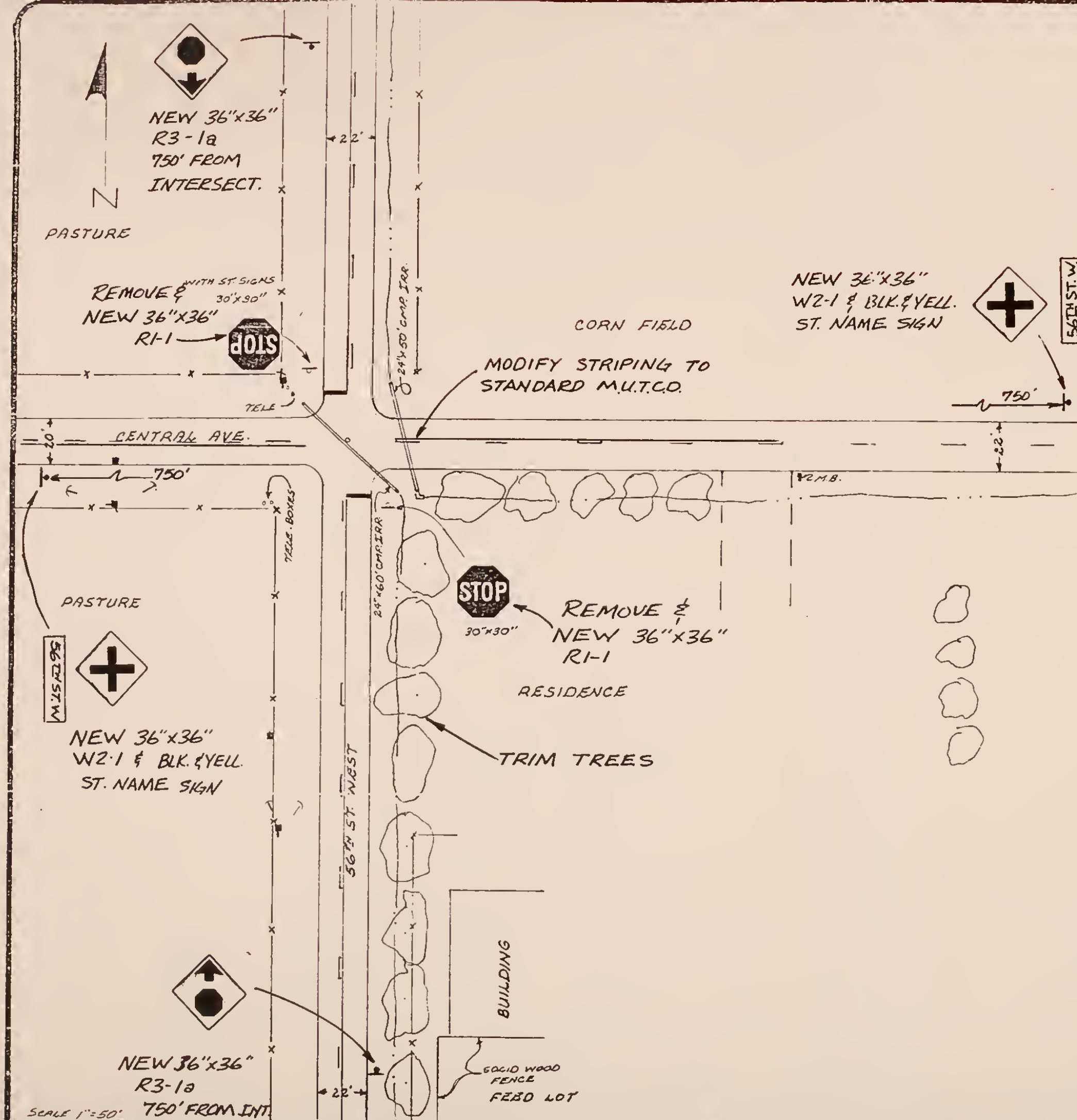


CENTRAL & 56TH STREET WEST - WESTBOUND



ACCIDENT STATISTICS -		CENTRAL AVE. - 56TH STREET W.	
ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 = 0		7 DRY =	100%
1985 = 0		0 WET =	0%
1986 = 1		0 ICY =	0%
1987 = 6	TOTAL = 7	LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :		2 DARK =	29%
0 HEAD ON =	0%	5 DAY =	71%
3 ANGLE =	43%	SEVERITY - % OF TOTAL :	
0 LEFT TURN =	0%	0 FATAL =	0%
1 SIDE SWIPE =	14%	6 INJURY =	86%
0 REAR END =	0%	1 PROP DAM =	14%
2 SINGLE V =	29%	ALCOHOL INVOLVED	
0 PEDEST. =	0%	% TOTAL =	
1 OTHER =	14%	2	
WEATHER CONDITIONS - % OF TOTAL :		29%	
5 CLEAR =	71%		
0 RAIN =	0%		
0 SNOW =	0%		
2 FOG =	29%		





SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : CENTRAL AVENUE & 56TH STREET WEST

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	3	0	40%	1.2	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	1	0	30%	0.3	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	1	1	20%	0.2	0.2
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	1	0	10%	0.1	0.0
TOTALS :	6	1	***	1.8	0.2

% REDUCTION IN INJURY/FATAL ACCIDENTS = 30.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 20.0%

CENTRAL AVENUE & 56TH STREET WEST

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGNS (6.1 TO 10 SF)	6	Ea	\$140.00	\$840.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	\$50.00	\$100.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	2	Ea	\$20.00	\$40.00
6	PAVE. MARKINGS (PAINT)	5	Gal	\$30.00	\$150.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	1	LS	\$500.00	\$500.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00
TOTAL CONSTRUCTION COSTS =					\$1,630.00

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2

BENCH BOULEVARD - TWO MOON PARK PRIORITY NUMBER 2

SITE DESCRIPTION

Bench Boulevard is a Collector Street within an area known as Billings Heights. It extends from an intersection with Main Street on the south to another intersection with Main Street near Mary Street on the north. It parallels Main Street for a distance of 2.5 miles. It functions as a collector road serving residential neighborhoods east of Main Street. At times it also accommodates overflow traffic from Main Street.

Two moon Park Road intersects Bench Boulevard from the east approximately .75 miles northeast of Main Street on the south end. Two Moon Park Road receives very little use. It mainly serves an ice skating arena in the southeast corner of the intersection.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Two curves along Bench Boulevard have been identified as accident cluster sites at this location. The first curve is approximately 1500 feet east of Main Street and the second curve is approximately 1000 feet north of the first at the entrance road to Two Moon Park. The road grade between the two locations is approximately 5% with northbound being the upgrade. There are several minor street approaches and driveways entering Bench Boulevard from the north along this stretch of roadway.

Traffic Control Devices. There is a moderate degree of signing and delineation present at this site. Pavement markings include a double solid yellow centerline. No date of installation is known for the existing signs. The signing includes speed limit signs and curve warning - delineation signing.

Traffic Volumes. Peak hour counts were taken during the morning peak (7:30 - 8:30 AM). By applying the appropriate factors, it was determined that the average daily traffic is approximately 1,100 on Bench Boulevard with 5% trucks and an incredible 20-80 directional split. Two Moon Park Road had zero entering and exiting traffic, which indicates its use is very low and infrequent.

Traffic Operations. The majority of drivers using Bench Boulevard are apparently familiar with the roadway and most likely use it on a daily basis. Vehicle speeds tend to be on the high side of the 35mph pace speed even on the curves. The curve advisory plate speeds seem to be appropriate for the conditions. Lack of sight distance does not cause motorists to apply their brakes and it is assumed that familiarity causes this complacency.

Accidents. The majority of accidents (5) occurred in 1984. No accidents were recorded in 1986 and 1985 and 1987 saw three accidents in each year. The southern most curve had three of the 11 total accidents while the curve near Two Moon Park experienced the remaining 7 accidents. The predominant accident was the single vehicle off road accident. The southern curve had a predominance of side swipe

accidents. The vast majority of accidents occurred on dry roads with clear weather conditions. However, 73% of the accidents occurred in the night time driving situation. Accident severity was relatively low with only 27% being injury type accidents.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the visibility of the vehicle travel path. Advance warning devices become invisible to drivers familiar with the road. The chevron signs which exist on the Two Moon Park curve have not been adjusted for maximum visibility. The signs appear to be mounted too high for maximum headlight refraction for northbound traffic. These signs should be lowered and supplemented with an additional arrow panel. Chevron signs should be added to the southern curve. If these signs visibly conflict with the existing barricades at the end of that curve, the barricades should be removed. Advanced warning signs should be enlarged to alert those unfamiliar drivers.

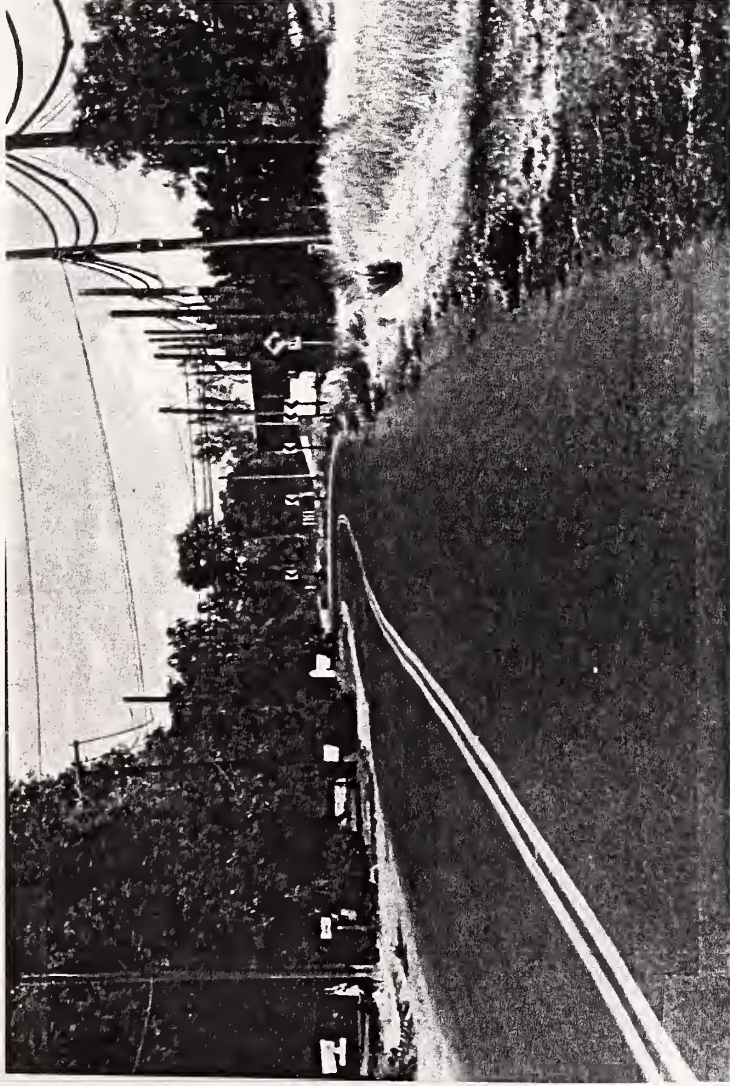
Delineation should be added through out the length of this section. Pavement edge lines will aid motorists blinded by oncoming headlamps aimed high due to grade changes.

The estimated cost of these improvements is \$2,900.00 based on 1988 unit bid contract prices.

Long term improvements at this location are contingent on the construction of a planned 6th Avenue N. - Bench Boulevard Connection Road. When this connection is built, Bench Boulevard will carry approximately 20,000 ADT at this point. The entire facility will have to be built to four lane standards and the curves flattened substantially.

BENEFITS

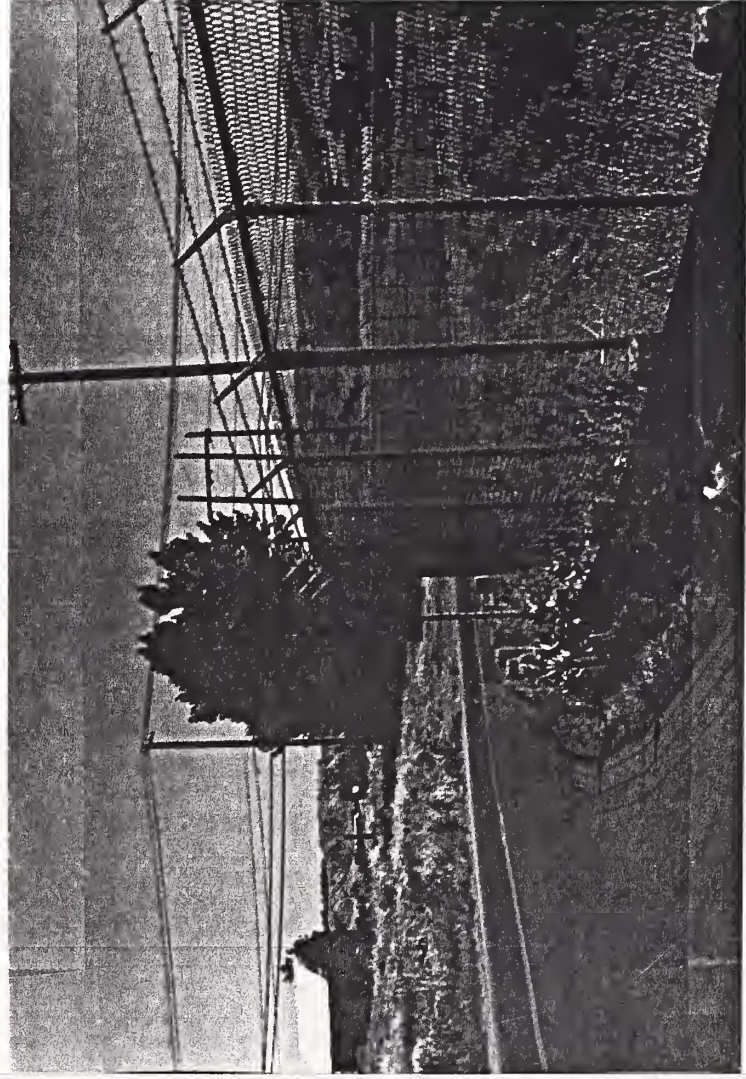
By improving definition of the roadway geometry to drivers, the single vehicle accident rate is expected to be reduced. The net benefit, according to stated methods, would be approximately \$ 10,914 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 12.62.



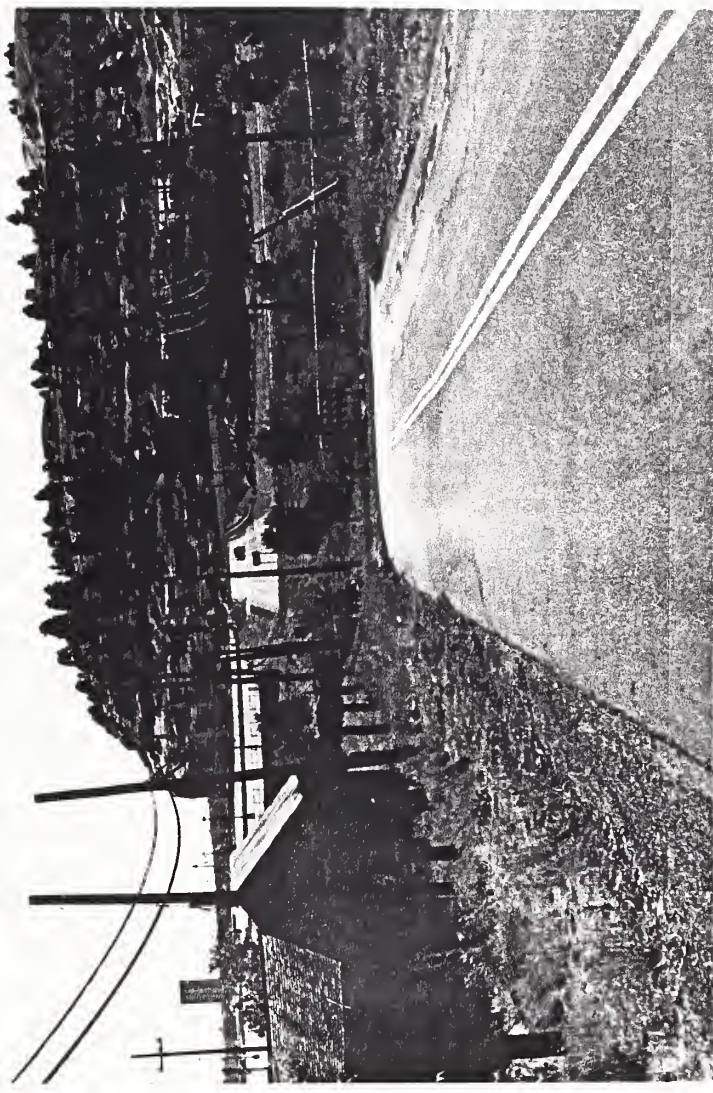
BENCH BOULEVARD, NORTH CURVE - NORTHBOUND



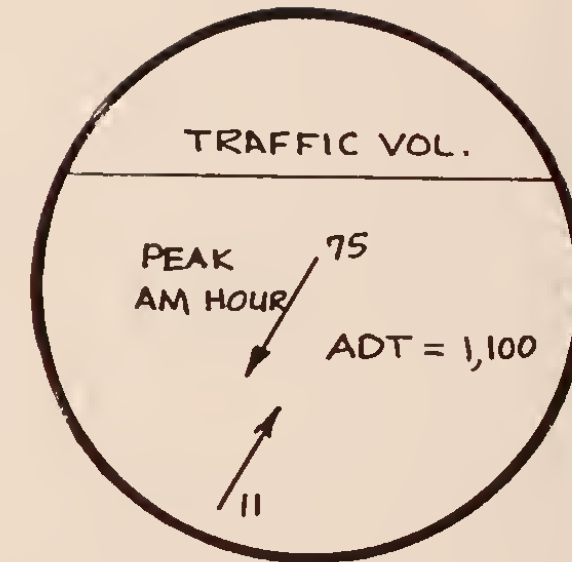
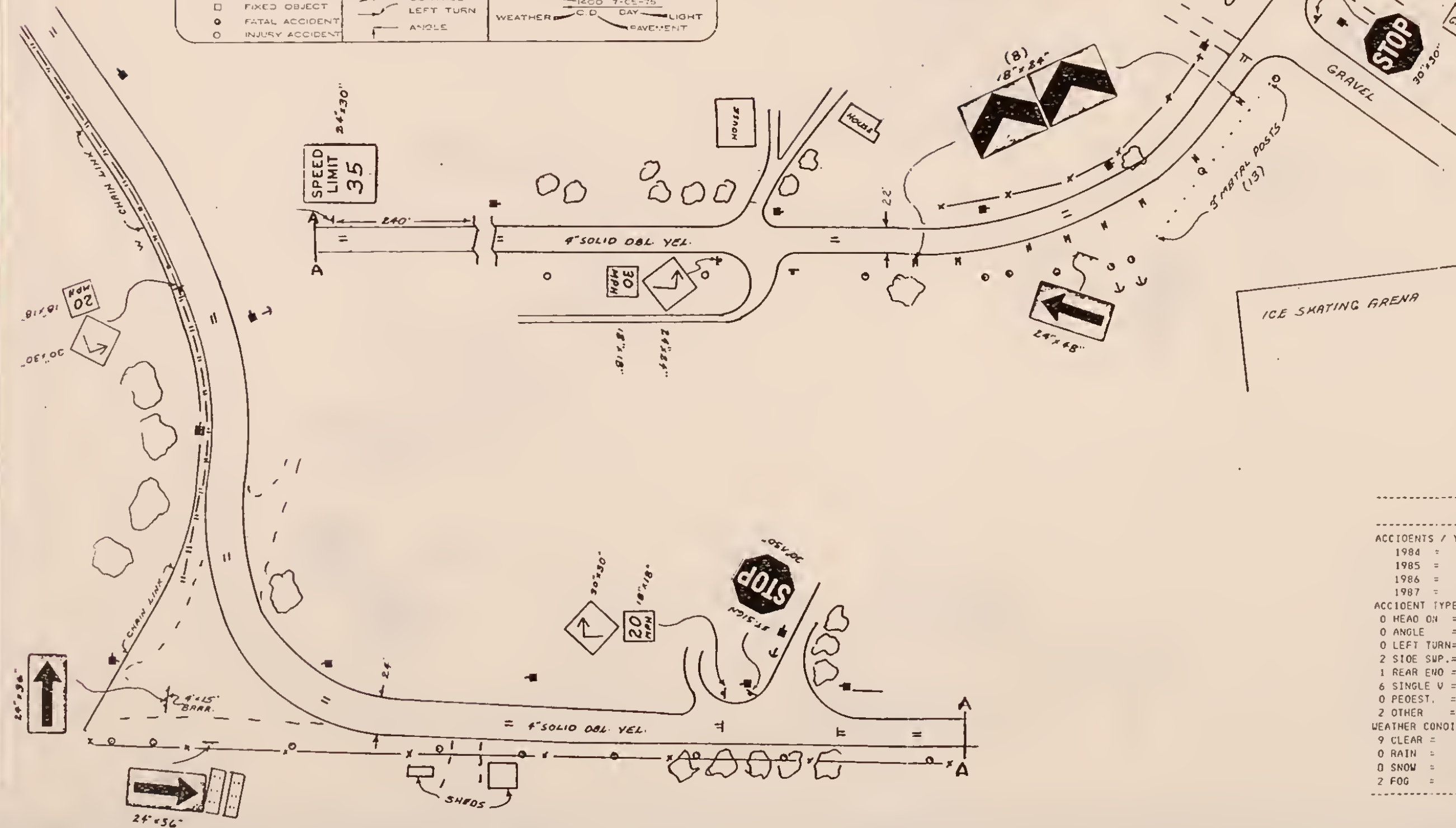
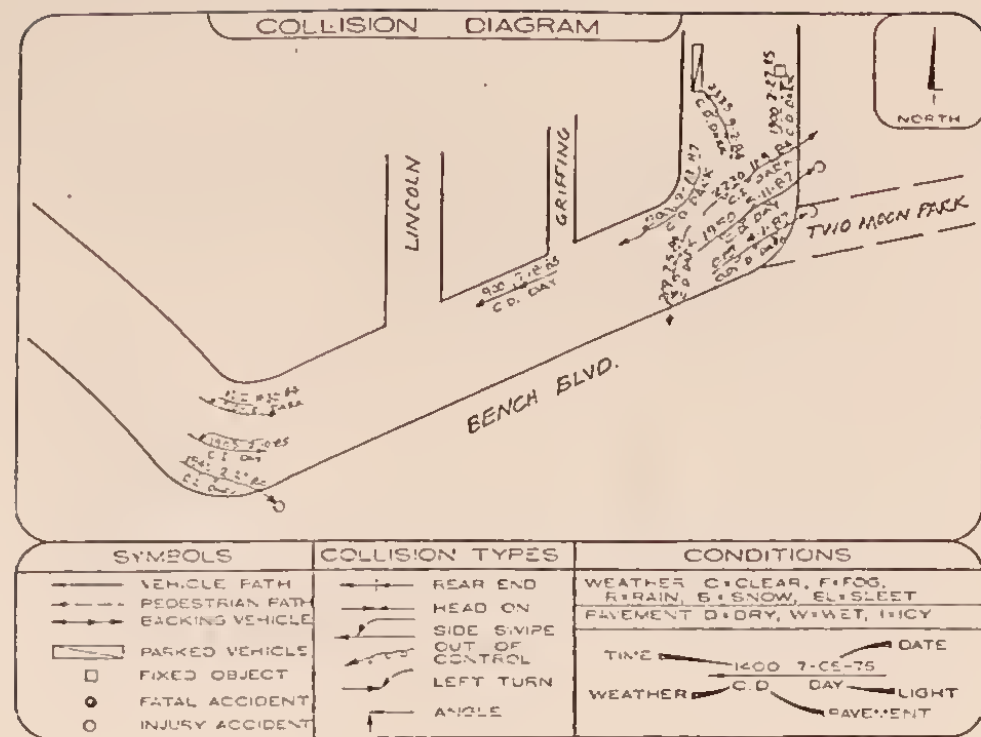
BENCH BOULEVARD, NORTH CURVE - SOUTHBOUND



BENCH BOULEVARD, SOUTH CURVE - NORTHBOUND



BENCH BOULEVARD, SOUTH CURVE - SOUTHBOUND



ACCIDENT STATISTICS - BENCH BOULEVARD	
ACCIDENTS / YEAR :	ROAD CONDITIONS - % OF TOTAL :
1984 = 5	9 DRY = 82%
1985 = 3	0 WET = 0%
1986 = 0	2 ICY = 18%
1987 = 3 TOTAL = 11	LIGHT CONDITIONS - % OF TOTAL :
ACCIDENT TYPE - % OF TOTAL :	8 DARK = 73%
0 HEAD ON = 0%	3 DAY = 27%
0 ANGLE = 0%	
0 LEFT TURN = 0%	SEVERITY - % OF TOTAL :
2 SIDE SWIPE = 18%	0 FATAL = 0%
1 REAR END = 9%	3 INJURY = 27%
6 SINGLE V = 55%	8 PROP DAM = 73%
0 PEDEST. = 0%	
2 OTHER = 18%	
WEATHER CONDITIONS - % OF TOTAL :	ALCOHOL INVOLVED 5
9 CLEAR = 82%	% TOTAL = 45%
0 RAIN = 0%	
0 SNOW = 0%	
2 FOG = 18%	

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : BENCH BOULEVARD @ TWO MOON PARK

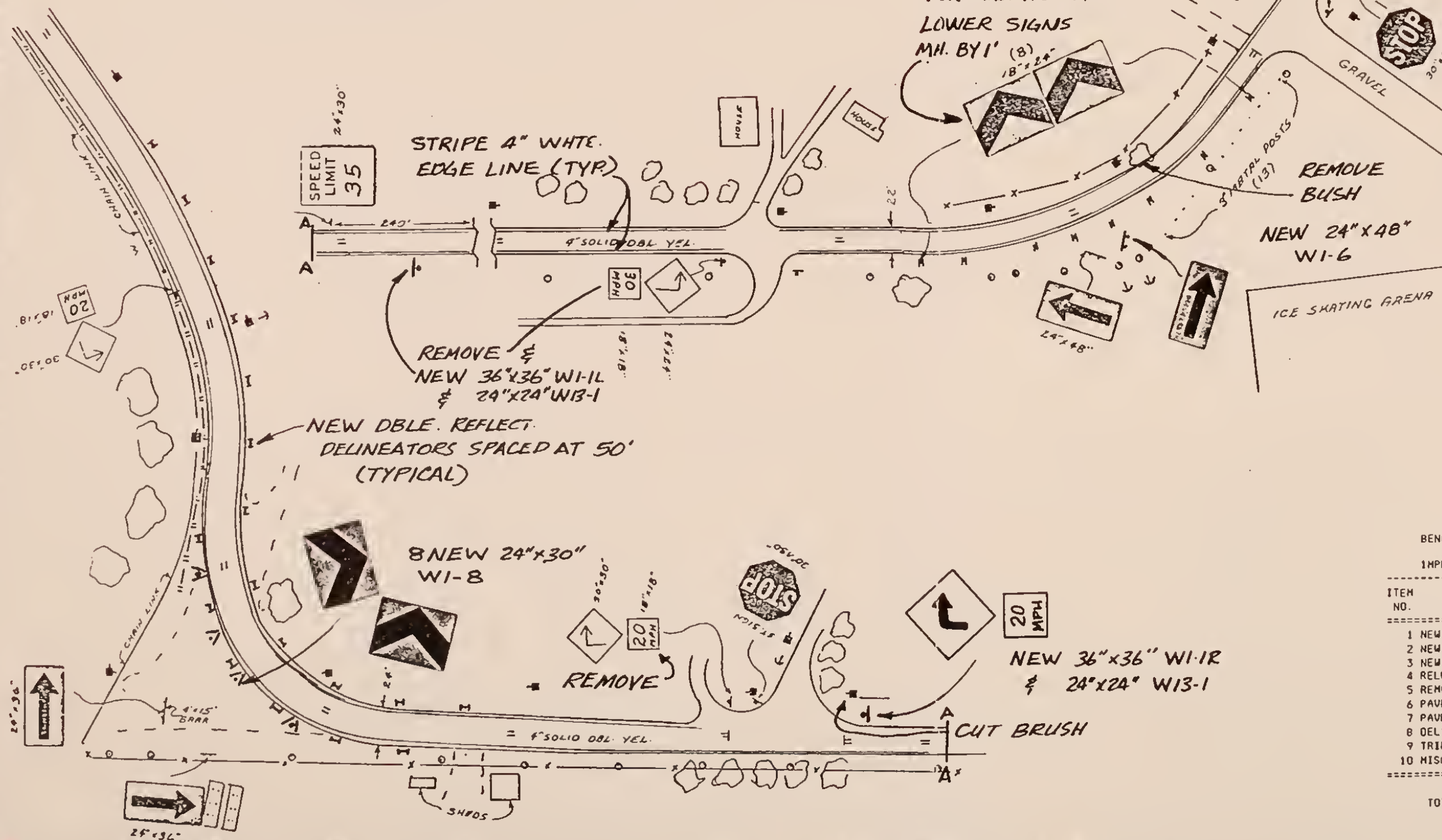
ACCIDENT TYPE	# ACC. IN PERIOD		CHANGE IN # ACC.		
	I/F	PD	EST. % CHANGE	I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	2	40%	0.0	0.8
REAR END	0	1	10%	0.0	0.1
SINGLE VEHICLE	3	3	50%	1.5	1.5
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	2	20%	0.0	0.4
TOTALS :	3	8	***	1.5	2.8

% REDUCTION IN INJURY/FATAL ACCIDENTS =

50.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS =

35.0%



BENCH BOULEVARD - TWO MOON PARK

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	8	Ea	\$100.00	\$800.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	\$140.00	\$560.00
3	NEW SUPPLEMENTARY SIGNS	3	Ea	\$50.00	\$150.00
4	RELOCATE SIGNS	8	Ea	\$40.00	\$320.00
5	REMOVE SIGNS	6	Ea	\$20.00	\$120.00
6	PAVE. MARKINGS (PAINT)	15	Gal	\$30.00	\$450.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	20	Ea	\$20.00	\$400.00
9	TRIM TREES	1	LS	\$100.00	\$100.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS =

\$2,900.00

S I T E

N U M B E R

3

CA ROAD 1.6 MILES N. SCANDIA ROAD PRIORITY NUMBER 3

SITE DESCRIPTION

CA Road is a county road providing access to farm & ranch areas north of Shepherd, Montana. It begins at Scandia Road, 2.5 miles east and 2.0 miles north of Shepherd. The northern terminus of CA Road is 13 miles north, where it merges with other isolated county roads.

The accident cluster site is within two miles of the beginning of CA Road and near a country subdivision and a large feedlot.

EXISTING CONDITIONS

Geometrics. Geometric features at the site are shown on the existing condition sketch. Two curves on CA at the beginning of a steep (8%) northbound upgrade are in a mountainous environment, unlike the remainder of the landscape. The roadway has a paved surface and appears to have been constructed within the past 5 to 10 years, judging by the pavement conditions.

The 0.3 mile section encompass a reverse curve with a slight curve interposed between them. The curves were not apparently engineered, since they are not simple curves nor curves with spirals. There is a "French Curve" element in their construction. A gradual curve leads abruptly into a sharper curve. Shoulders and side slopes are better than most county or secondary roads in slope conditions.

Traffic Control Devices. There is a moderate degree of signing present at this site. Pavement markings include what appears to be appropriately striped centerlines. No date of installation is known for the existing signs. The signing includes curve warning signs.

Traffic Volumes. Manual traffic counts were taken at the site. It was determined that the average daily traffic is approximately 450 ADT, 40% of which is truck traffic.

Traffic Operations. Due to the low volume of traffic, it was not possible to draw any definitive conclusions regarding the operational characteristics of the roadway with respect to average driver behavior. While conducting subjective index value studies on the site, it was determined that the non conventional nature of the curve geometrics would lead a driver into a dangerous situation because the beginning of the curves are more gradual than the ends of the curves. Also, it appears that the speed advisory plates were installed at the wrong curves. The 25 mph curve can easily be traversed at 35-40 mph while the 35 mph curve is closure to 30-53mph. This situation grossly misinforms the motorist.

Accidents. There were three accidents at this site. Two were in 1984 and 1 in 1986. All of the accidents were single vehicle accidents occurring on the northern most curve with vehicles headed southbound. This is the curve with the most restrictive geometric

conditions. The weather and roads were clear and dry in all cases and in 2/3 of the accidents, it was daytime. All of the accidents resulted in injuries.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. The improvements basically consist of warning signs and delineation.

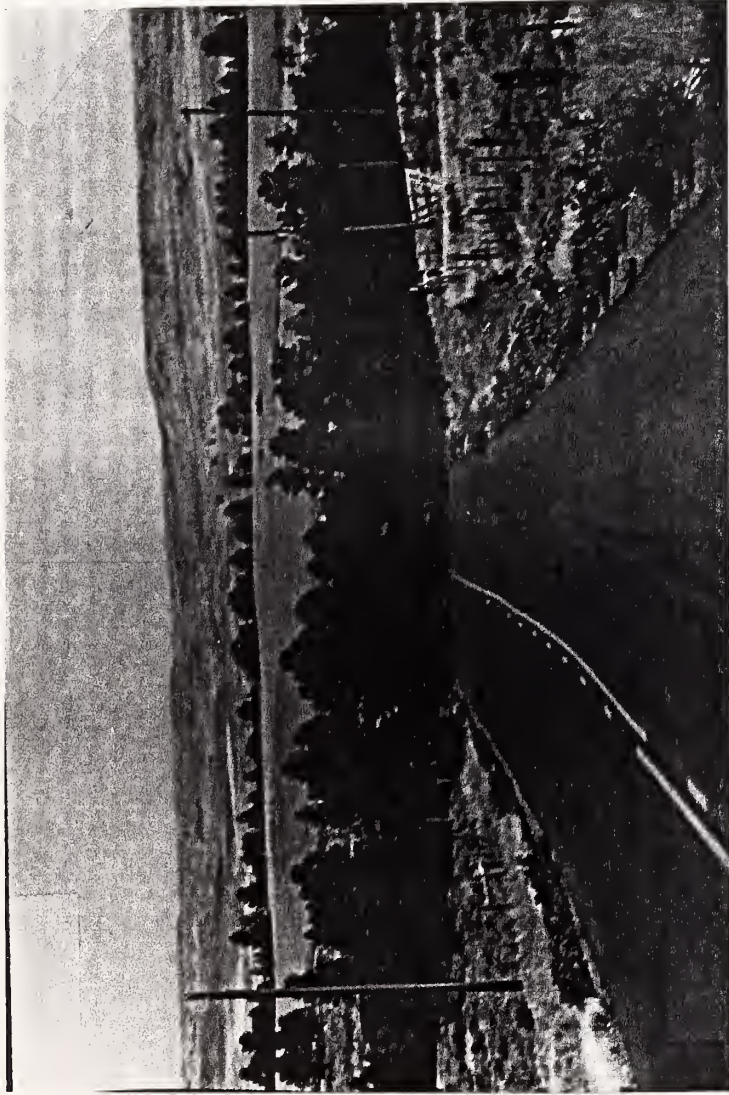
The main purpose of these recommendations is to increase the visibility of the vehicle travel path and provide advance warning which accurately reflects the conditions to be encountered. The existing right angle turn signs were misapplied and they did not adequately warn motorists of the reverse curve conditions.

The estimated cost of these improvements is \$2,420.00 based on 1988 unit bid contract prices.

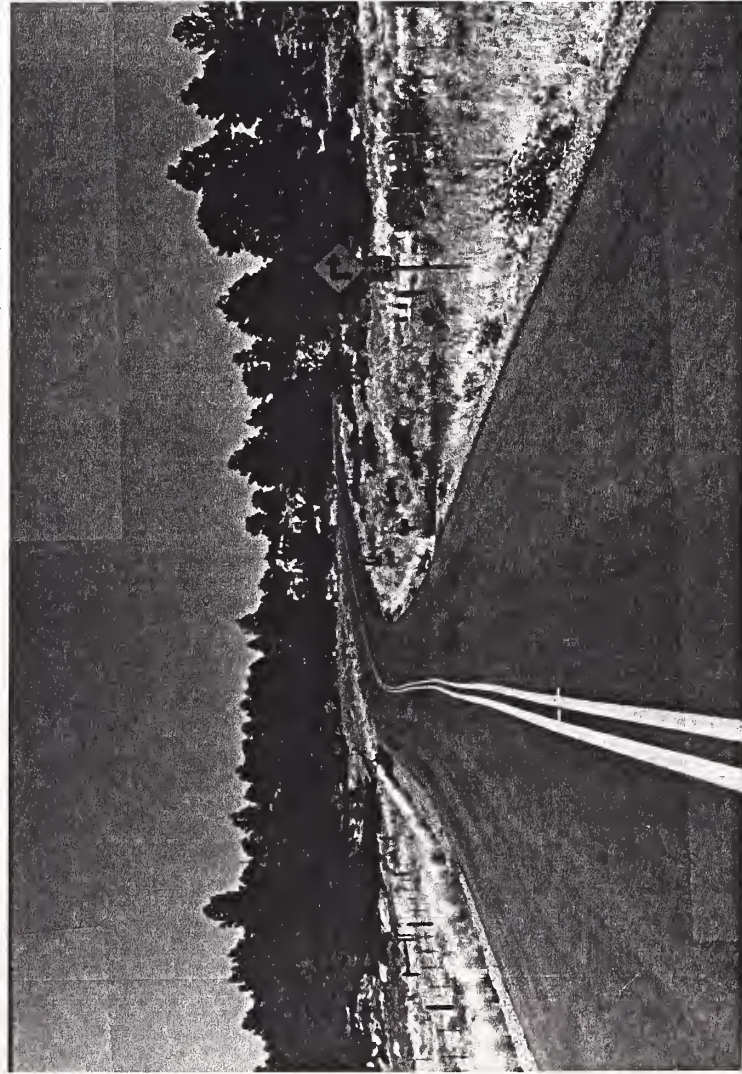
Long term improvements at this location are not possible to predict considering the isolation of this site and the improbable growth that could occur.

BENEFITS

Improvements to advanced warning and delineation at this site may provide a significant reduction in accident experience. The net benefit, according to stated methods, would be approximately \$ 7,808 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 11.34.



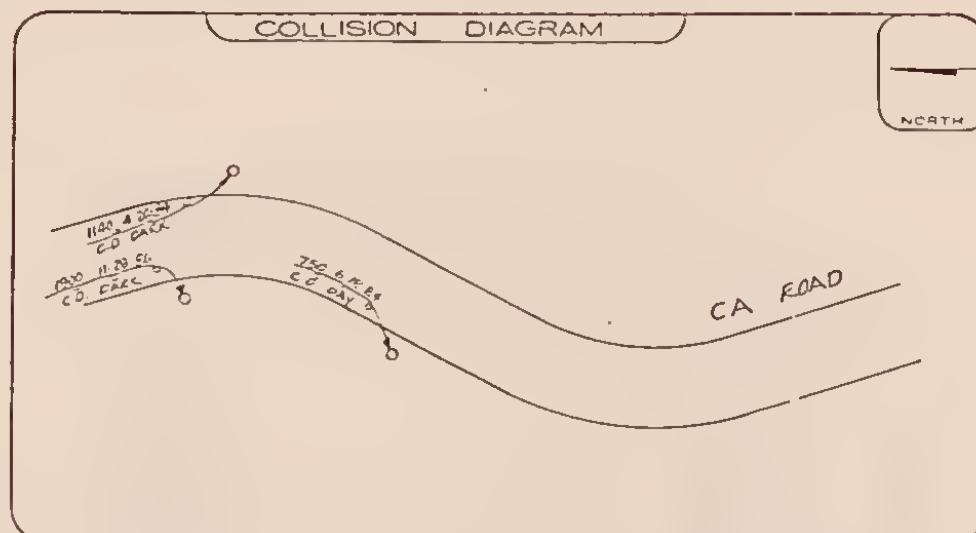
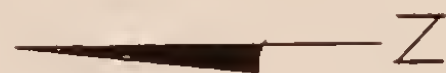
CA ROAD 1.8 MILES - SOUTHBOUND



CA ROAD, 1.6 MILES - NORTH BOUND



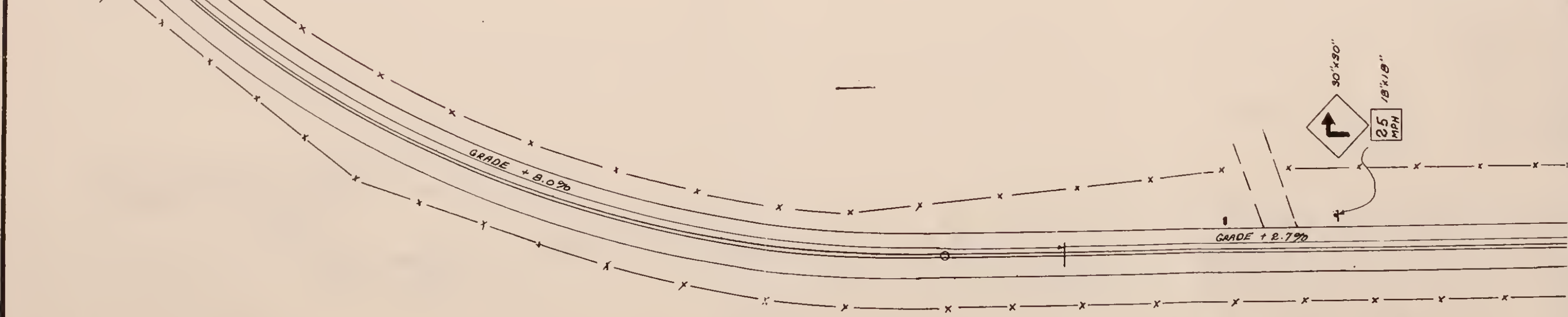
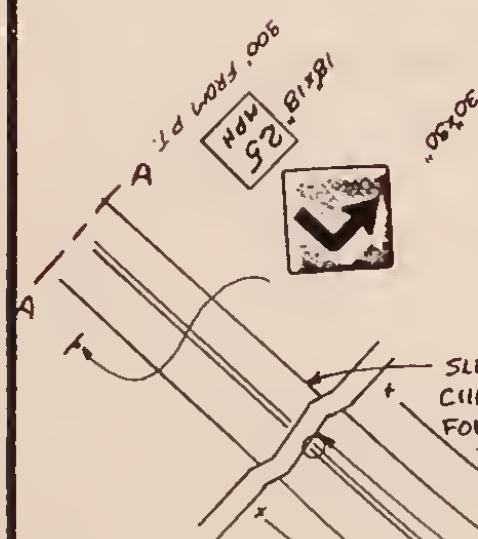
CA ROAD, 1.6 MILES - SOUTHBOUND



SYMBOLS	COLLISION TYPES	CONDITIONS
— VEHICLE PATH	REAR END	WEATHER C=CLEAR, F=FOG, R=RAIN, S=SNOW, SL=SLEET
- - - PEDESTRIAN PATH	HEAD ON	PAVEMENT D=DRY, W=WET, I=ICY
- - - BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
▭ PARKED VEHICLE	CUT OF CONTROL	WEATHER C.D. DAY LIGHT
● FATAL ACCIDENT	LEFT TURN	PAVEMENT
○ INJURY ACCIDENT	ANGLE	

ACCIDENT STATISTICS -		CA ROAD	
-----		-----	
ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 =	2	3 DRY =	100%
1985 =	0	0 WET =	0%
1986 =	1	0 ICY =	0%
1987 =	0 TOTAL = 3	LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :		2 DARK =	67%
0 HEAD ON =	0%	1 DAY =	33%
0 ANGLE =	0%	SEVERITY - % OF TOTAL :	
0 LEFT TURN=	0%	0 FATAL =	0%
0 SIDE SWP.=	0%	3 INJURY =	100%
0 REAR END =	0%	0 PROP OAH=	0%
3 SINGLE V =	100%		
0 OTHER =	0%		
WEATHER CONDITIONS - % OF TOTAL :		ALCOHOL	2
3 CLEAR =	100%	INVOLVED	
0 RAIN =	0%	% TOTAL =	67%
0 SNOW =	0%		
0 FOG =	0%		

ADT = 450
← 16
→ 29
PEAK AM HOUR



MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS, MT 59107
Ph. (406) 246-6066

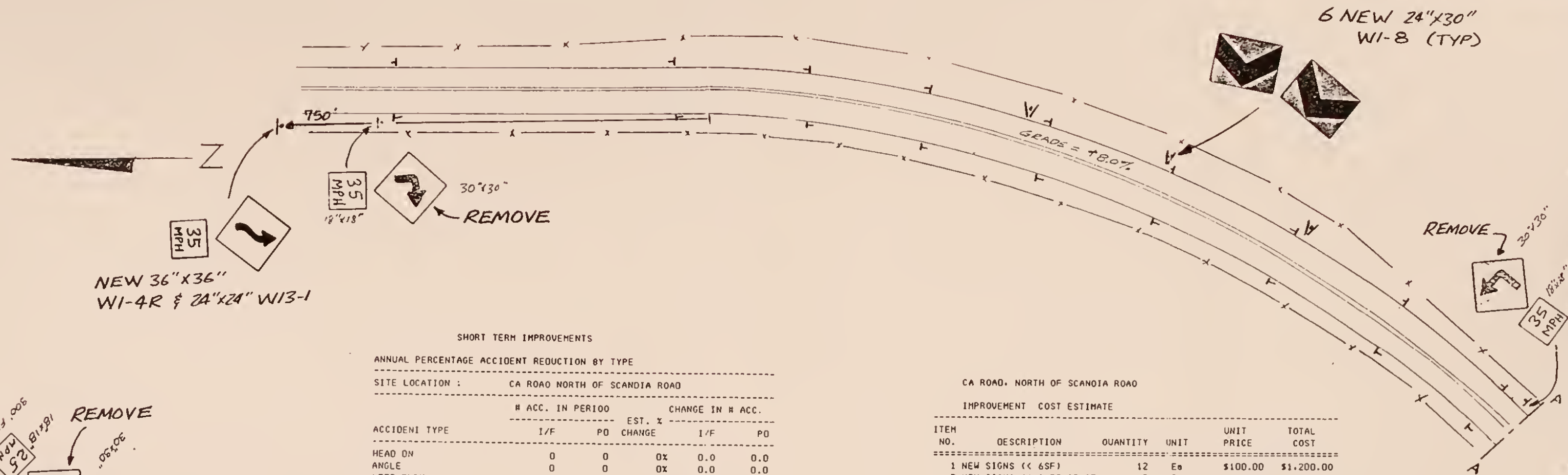
Project: **TRAFFIC SAFETY STUDY
YELLOWSTONE COUNTY**

Sheet Title: **CA ROAD
EXISTING CONDITIONS**

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Revisions
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No. _____
Sheet No. **1**
of **1**



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION :

CA ROAD NORTH OF SCANDIA ROAD

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	3	0	40%	1.2	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	3	0	***	1.2	0.0

% REDUCTION IN INJURY/FATAL ACCIDENTS = 40.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS =

ERR

CA ROAD, NORTH OF SCANDIA ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	12	Ea	\$100.00	\$1,200.00
2	NEW SIGNS (6.1 TO 10 SF)	2	Ea	\$140.00	\$280.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	\$50.00	\$100.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	8	Ea	\$20.00	\$160.00
6	PAVE. MARKINGS (PAINT)	0	Gal	\$30.00	\$0.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	34	Ea	\$20.00	\$680.00
9	TRIM TREES	0	LS	\$0.00	\$0.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS =

\$2,420.00

NEW DELINEATORS
SPACED AS PER M.U.T.C.D.
(TYPICAL)

6 NEW 24"x30"
WI-8 (TYP)

NEW 36"x36"
WI-4R &
24"x24" WI-3-I



MARVIN & ASSOCIATES

SUITE 304 TRANSWESTERN I
404 N 31st
BILLINGS MT 59107

Traffic Transportation & Civil Engineers Ph (406) 248-6088

Project:

TRAFFIC SAFETY STUDY
YELLOWSTONE COUNTY

Sheet Title:

CA ROAD
SHORT TERM IMPROVEMENTS

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Reviewed By: _____
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No.

Sheet No.

1

of 1

SITE

NUMBER

4

INDIAN CAVES ROAD

PRIORITY NUMBER 4

SITE DESCRIPTION

Indian Caves Road is a continuation of Coburn Road, which begins at a junction with Highway 87 near the Lockwood I-90 Interchange on the north end and extends south 2.5 miles where it becomes the Indian Caves Road. Indian Caves Road begins at that point and extends southerly another 2.5 miles and ends at a state historical monument.

It is primarily a recreational type road with most of the activity occurring during the summer months. At present there is a gate at the beginning of the road and access is restricted to the hours between 8 Am and 8 PM.

The accident cluster site is between 4.0 and 4.5 miles south of the U.S. 87 junction.

EXISTING CONDITIONS

Geometrics. Geometric features at the site are shown on the existing condition sketch. A series of horizontal and vertical curves comprise the section of road in question. Vertical grades vary between flat and 12%. The characteristics of the gravel road are similar to a mountain road or a logging road.

There are several blind curves. There is no shoulder and the roadside slopes are abrupt. Power poles are located within several feet of the roads edge.

Traffic Control Devices. There are no traffic control devices of any sort at the cluster site nor anywhere along the entire length of roadway.

Traffic Volumes. manual traffic counts were taken at the site. It was determined that the average daily traffic is approximately 200 ADT.

Traffic Operations. Due to the low volume of traffic, it was not possible to draw any definitive conclusions regarding the operational characteristics of the roadway with respect to average driver behavior. While conducting subjective index value studies on the site, it was determined that the roadway is a typical gravel mountain road. Several areas have a wash board surface which causes a lack of steering control. The curves at the cluster site are not typical of what would be encountered on the remainder of the road and some speed adjustment is necessary to successfully negotiate the turns.

Accidents. There were five accidents at this site. Two were in 1984 and 1 each in 1985, 1986 and 1987. All of the accidents were single vehicle accidents occurring on separate curves. The weather and roads were clear and dry in almost all cases. A fact that is puzzling, 60% of the accidents were at night when the road is supposed to closed. It is not known whether the hour restrictions were recently imposed or not. Eighty percent of the accidents were injury type accidents.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. The improvements basically consist of warning signs and delineation.

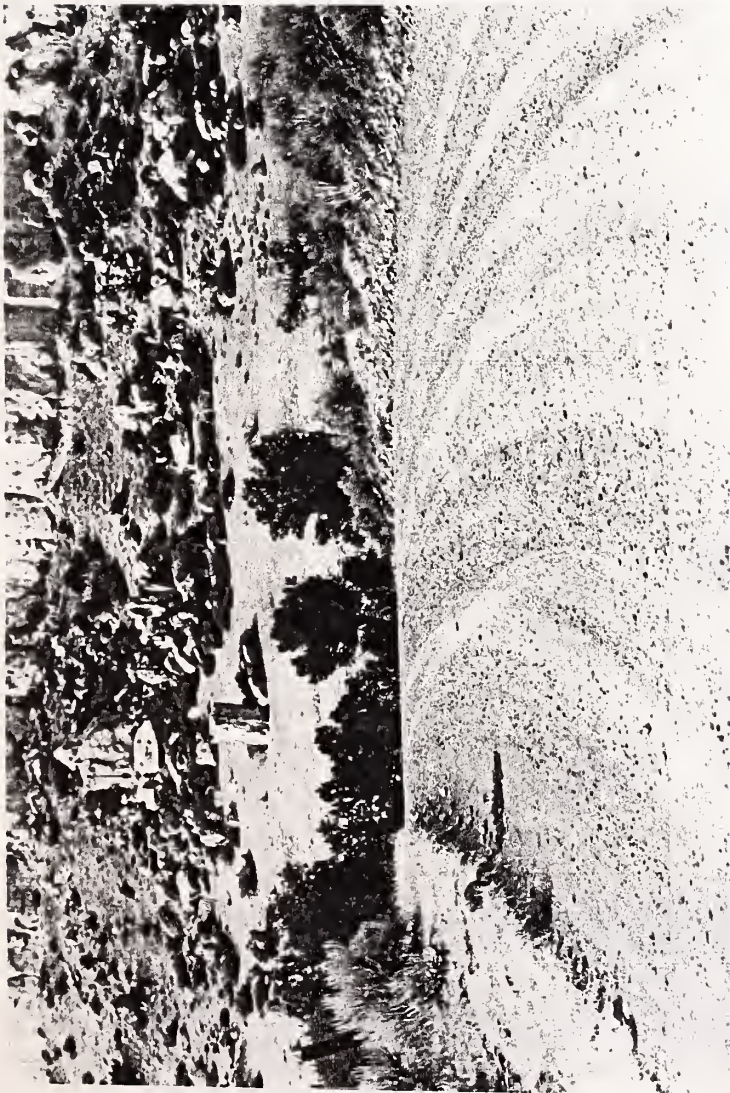
The main purpose of these recommendations is to increase the visibility of the vehicle travel path and provide advance warning which accurately reflects the conditions to be encountered.

The estimated cost of these improvements is \$3,320.00 based on 1988 unit bid contract prices.

Long term improvements at this location should include realignment of both vertical and horizontal curves. The existing roadway basically follows the lay of the land. Drastic improvements could be realized with only a moderate amount of earthwork. The right-of-way question would be the only possible detriment to making better and more permanent improvements. The state agency responsible for the historical site should be contacted to determine if funding could be made available to improve access conditions.

BENEFITS

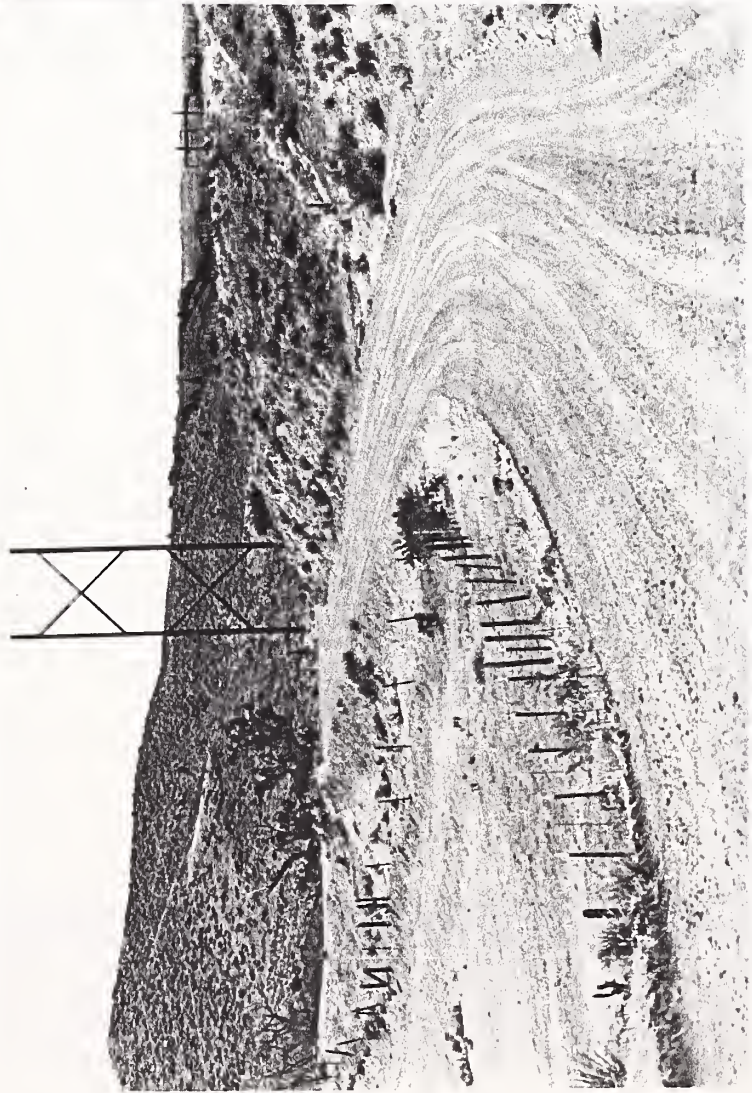
Improvements to advanced warning and delineation at this site may provide a significant reduction in accident experience. The net benefit, according to stated methods, would be approximately \$ 9,275 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 10.02.



INDIAN CAVES RD, MILE 4.3 - NORTHBOUND



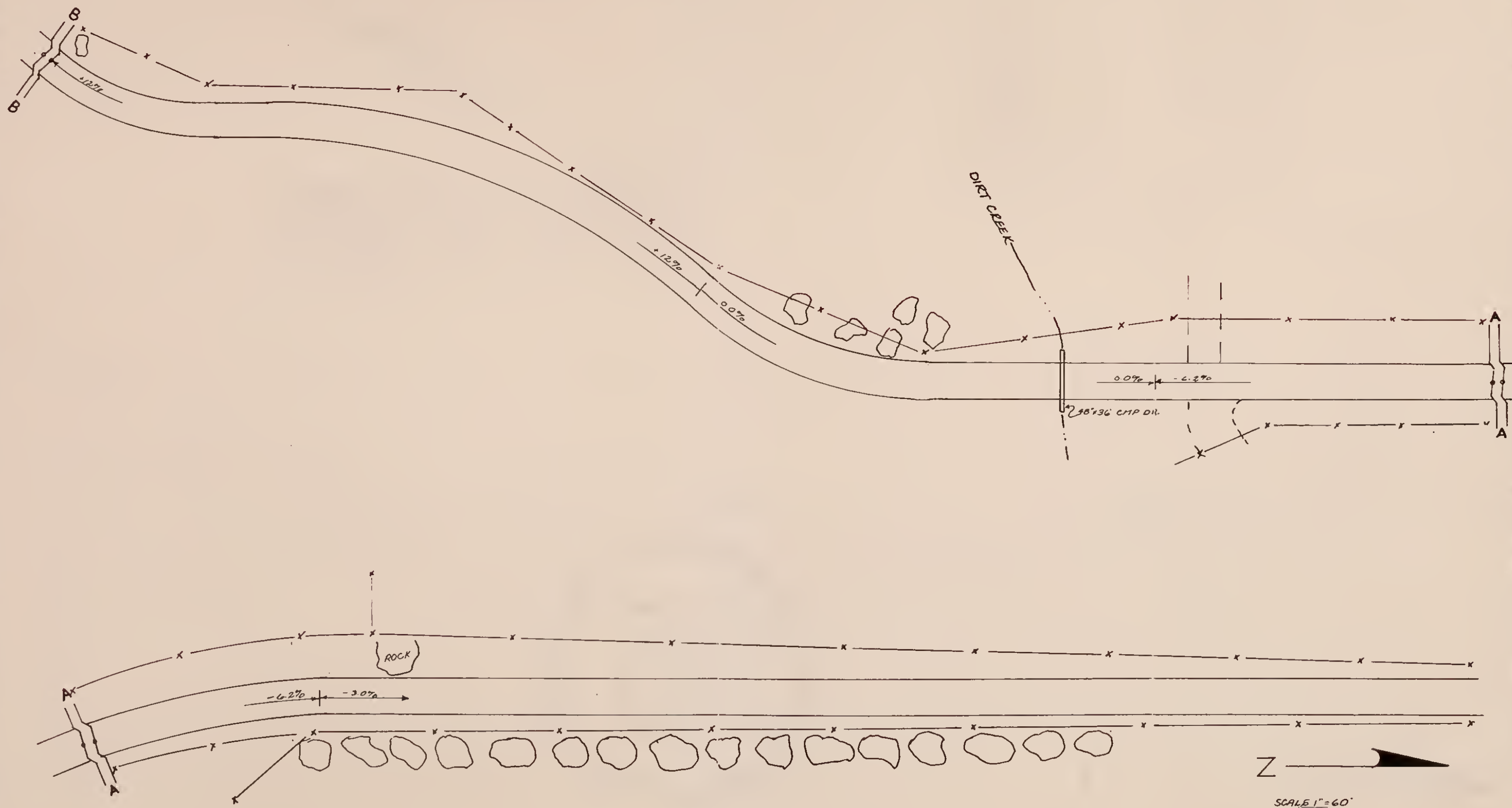
INDIAN CAVES RD, MILE 4.3 - SOUTHBOUND



INDIAN CAVES RD, MILE 4.5 - NORTHBOUND



INDIAN CAVES RD, MILE 4.5 - SOUTHBOUND



MARVIN & ASSOCIATES

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Project:

TRAFFIC SAFETY STUDY
YELLOWSTONE COUNTY

Sheet Title:

INDIAN CAVES ROAD
EXISTING CONDITIONS

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

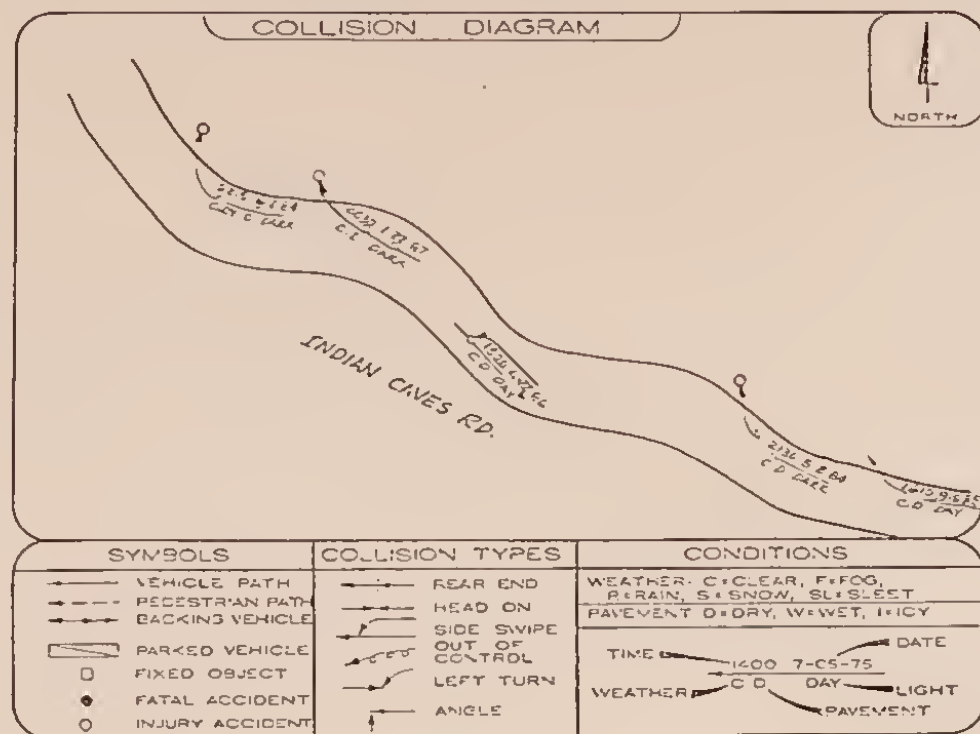
Revisions	
No. _____	Date _____
No. _____	Date _____
No. _____	Date _____
No. _____	Date _____

Project No. _____

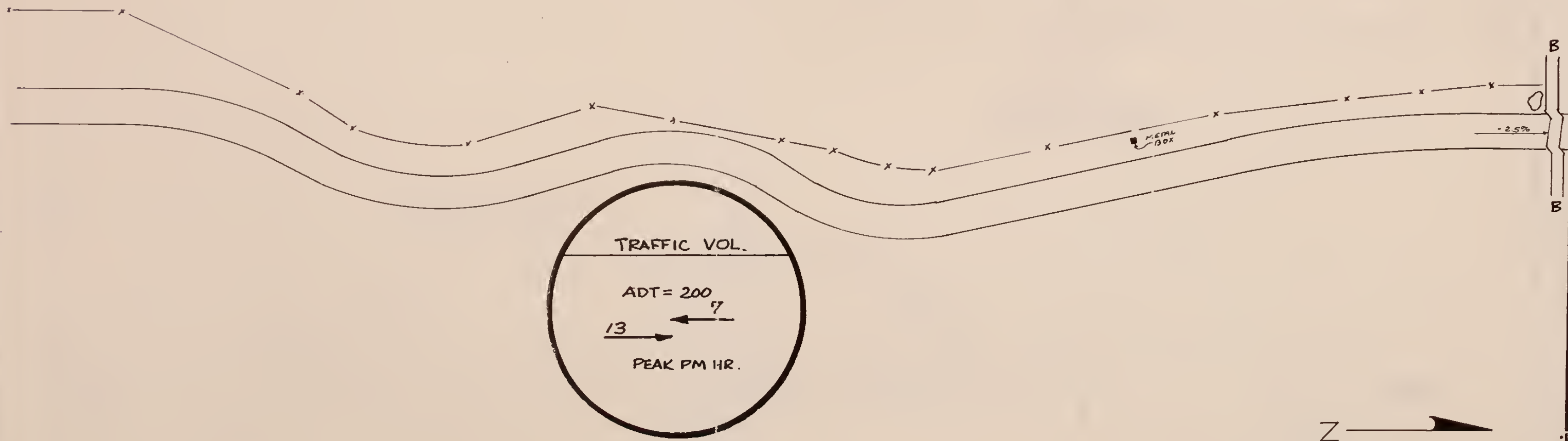
Client No. _____

Sheet No.

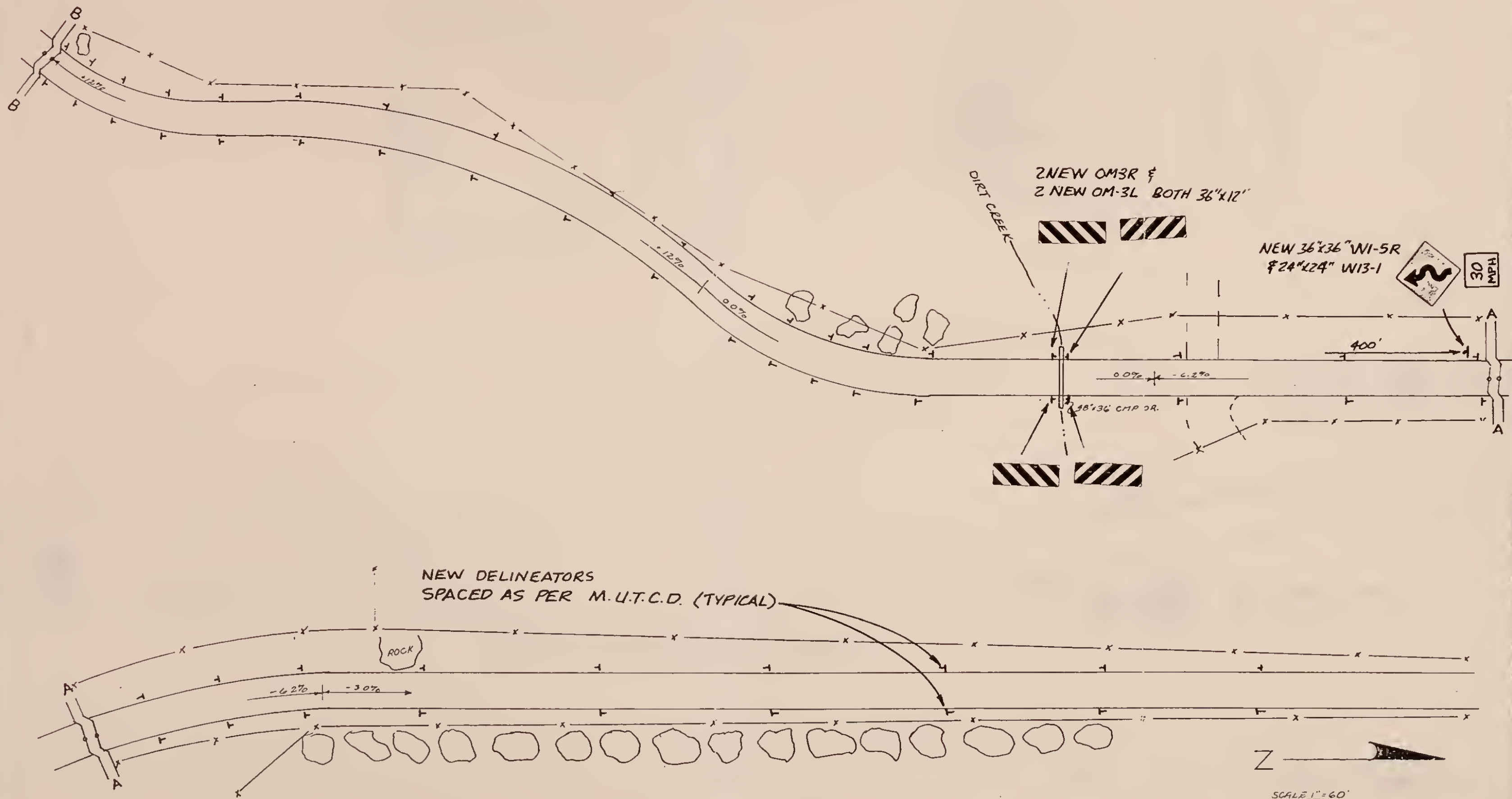
1
of 2



ACCIDENT STATISTICS - INDIAN CAVES ROAD	
ACCIDENTS / YEAR :	ROAD CONDITIONS - % OF TOTAL :
1984 = 2	4 DRY = 80%
1985 = 1	0 WET = 0%
1986 = 1	1 ICY = 20%
1987 = 1 TOTAL = 5	LIGHT CONDITIONS - % OF TOTAL :
ACCIDENT TYPE - % OF TOTAL :	3 DARK = 60%
0 HEAD ON = 0%	2 DAY = 40%
0 ANGLE = 0%	SEVERITY - % OF TOTAL :
0 LEFT TURN = 0%	0 FATAL = 0%
1 SIDE SWP. = 20%	4 INJURY = 80%
0 REAR END = 0%	1 PROP DAM = 20%
4 SINGLE V = 80%	
0 OTHER = 0%	
WEATHER CONDITIONS - % OF TOTAL :	ALCOHOL INVOLVED 4
4 CLEAR = 80%	% TOTAL = 80%
0 RAIN = 0%	
0 SNOW = 0%	
1 FOG = 20%	



SCALE 1"=60'



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : INDIAN CAVES ROAD

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PO		I/F	PO
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	1	0	20%	0.2	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	3	1	40%	1.2	0.4
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	4	1	***	1.4	0.4

% REDUCTION IN INJURY/FATAL ACCIDENTS = 35.0%

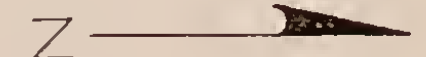
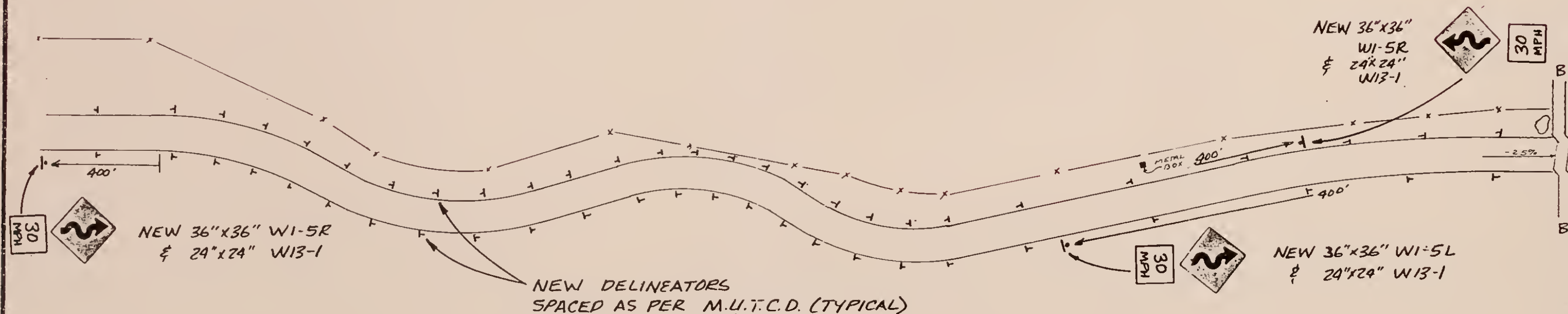
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 40.0%

INDIAN CAVES ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	4	Ea	\$100.00	\$400.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	\$140.00	\$560.00
3	NEW SUPPLEMENTARY SIGNS	4	Ea	\$50.00	\$200.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	0	Ea	\$20.00	\$0.00
6	PAVE. MARKINGS (PAINT)	0	Gal	\$30.00	\$0.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	108	Ea	\$20.00	\$2,160.00
9	TRIM TREES	0	LS	\$0.00	\$0.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$3,320.00



SCALE 1"=60'

SITE

NUMBER

5

DRURY LANE & HOSKINS ROAD

PRIORITY NUMBER 5

SITE DESCRIPTION

Drury Lane and Hoskins Road are both local county roads located northeast of Billings. Drury lane extends 1.5 miles from an intersection with Highway 312 on the west to the intersection with Hoskins Road on the east.

Hoskins Road begins just south of the subject intersection and continues north through and intersection with Highway 312 and extends to a point 7.0 miles north of the intersection.

These roads serve local traffic which mostly agricultural related. The intersection is isolated from any existing or future traffic generators.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the "T" intersection are less than 1% on all legs. Both roads are paved and the road cross section is typical of all Yellowstone County roads.

Traffic Control Devices. Pavement markings at this site were sparse. Only the remnants of a white edge line was found near the intersection.

Signing consists of an intersection warning sign on Drury Lane and a yield sign. There is also an arrow panel at the head of the "T" for Drury Lane approach traffic. This sign has been vandalized and is fairly well camouflaged.

Traffic Volumes. Peak hour counts were taken during the morning peak hour. By applying the appropriate factors, it was determined that the average daily traffic is approximately 220 on Drury Lane and 250 on Hoskins Road.

Traffic Operations. It is apparent that the yield sign was installed because nobody stopped at the intersection. Traffic volumes being so low, that it is a rarity to have two vehicles in the intersection at the same time. The signing, even if misapplied, does draw attention to the intersection for approach vehicles on Drury Lane. However, Hoskin Road southbound traffic has no clue that an intersection is present. It would be hard to judge its location even to the most familiar drivers.

Accidents. There were two accidents in 1984 and one each in 1985 and 1986. No accidents occurred in 1987. The predominant accident involved the eastbound movement. Drivers apparently fail to realize that the intersection is so near or that it is a "T" intersection and drive through the arrow panel. The severity of these accidents is high with 75% of the accidents being injury accidents. These accidents occurred on dry roads in clear weather. fifty percent of the accidents occurred at night.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting of sign replacements, new traffic control devices and pavement markings.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new stop ahead sign and replacement of the existing yield sign with a stop sign should greatly aid in reinforcing the drivers decision in adjusting approach speed. The existing "T" warning sign was used incorrectly according to MUTCD and probably gave conflicting or confusing messages to drivers. As additional reinforcement, it is recommended that the striping be modified at the intersection.

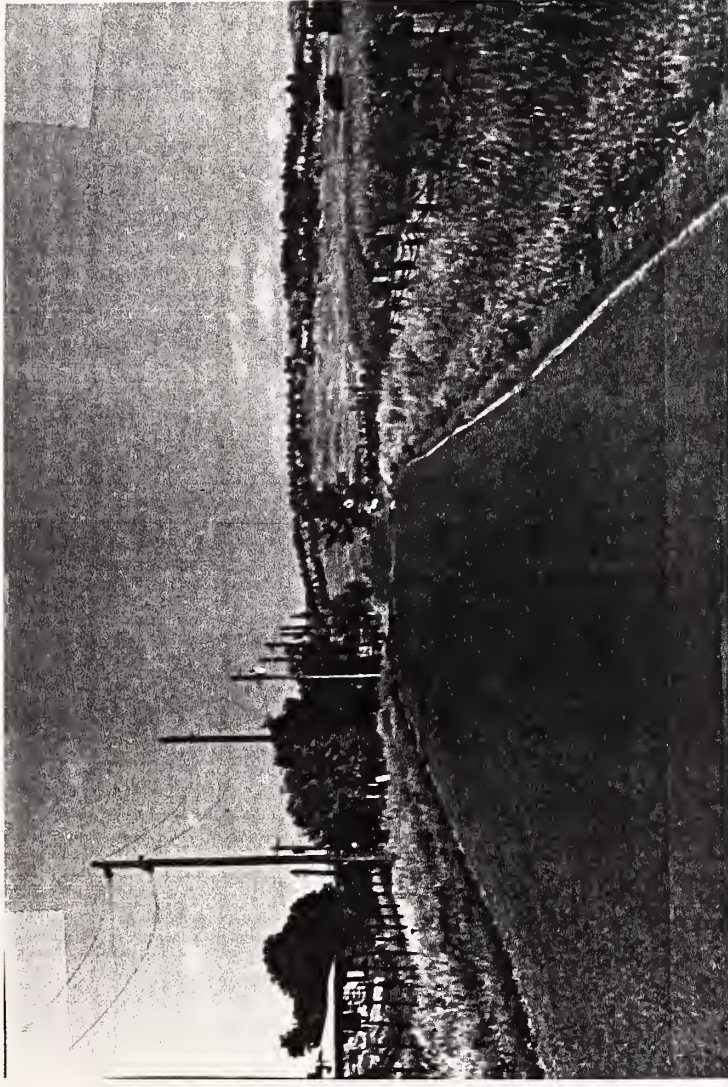
To improve information deficiencies for Hoskins southbound traffic, new intersection warning signs with the supplementary name plates should be located 750 feet from the intersection.

The estimated cost of these improvements is \$1,030.00 based on 1988 unit bid contract prices.

Long term improvements cannot be suggested at this point, since the degree of future traffic growth and the construction of alternate access facilities cannot be predicted with any certainty. It is assumed that volumes will not reach a critical stage within the next 20 years.

BENEFITS

By improving driver expectancy, the single vehicle accident rate is expected to be reduced. The net benefit, according to stated methods, would be approximately \$ 7,808 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 24.27, the highest of any of the sites.



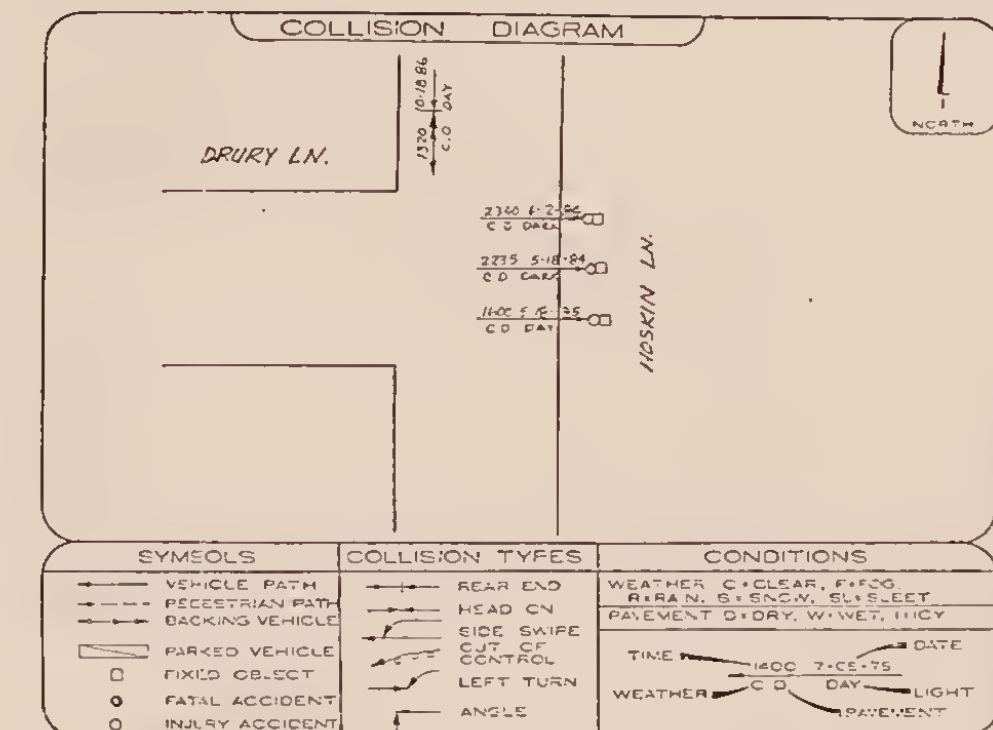
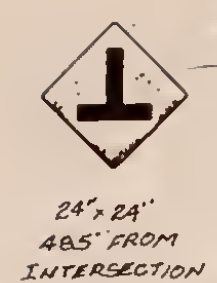
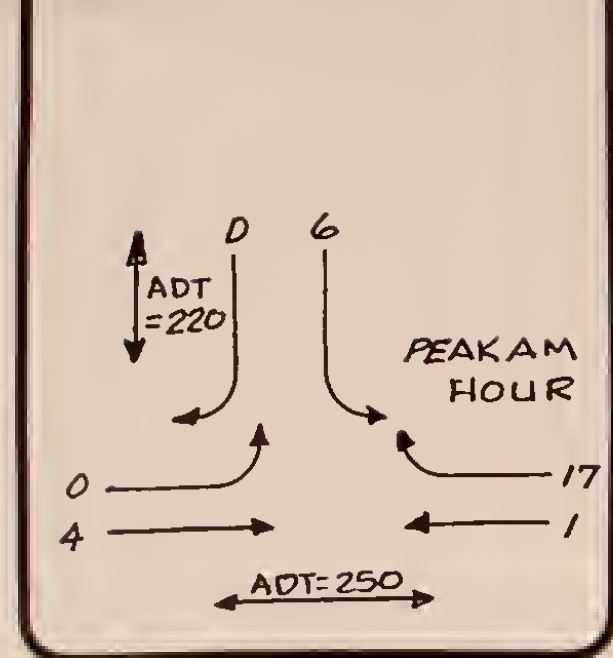
DRURY LANE - EASTBOUND



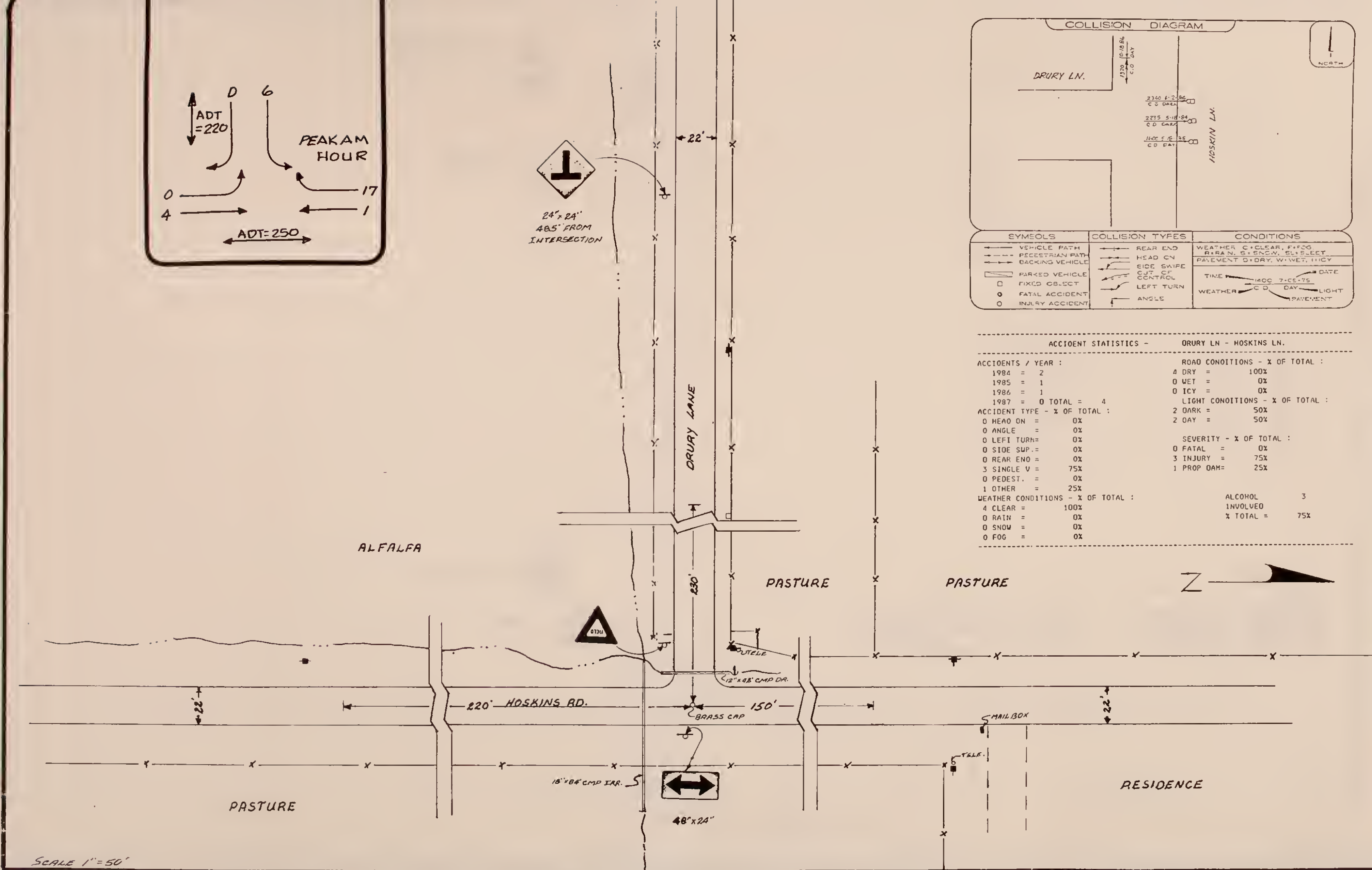
HOSKINS ROAD - NORTHBOUND



HOSKINS ROAD - SOUTHBOUND



ACCIDENT STATISTICS -		DRURY LN - HOSKINS LN.	
ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 = 2		4 DRY = 100%	
1985 = 1		0 WET = 0%	
1986 = 1		0 ICY = 0%	
1987 = 0	TOTAL = 4	LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :		2 DARK = 50%	
0 HEAD ON = 0%		2 DAY = 50%	
0 ANGLE = 0%		SEVERITY - % OF TOTAL :	
0 LEFT TURN = 0%		0 FATAL = 0%	
0 SIDE SWP. = 0%		3 INJURY = 75%	
0 REAR END = 0%		1 PROP DAM = 25%	
3 SINGLE V = 75%		ALCOHOL INVOLVED	
0 PEDEST. = 0%		3	
1 OTHER = 25%		% TOTAL = 75%	
WEATHER CONDITIONS - % OF TOTAL :			
4 CLEAR = 100%			
0 RAIN = 0%			
0 SNOW = 0%			
0 FOG = 0%			



SCALE 1" = 50'

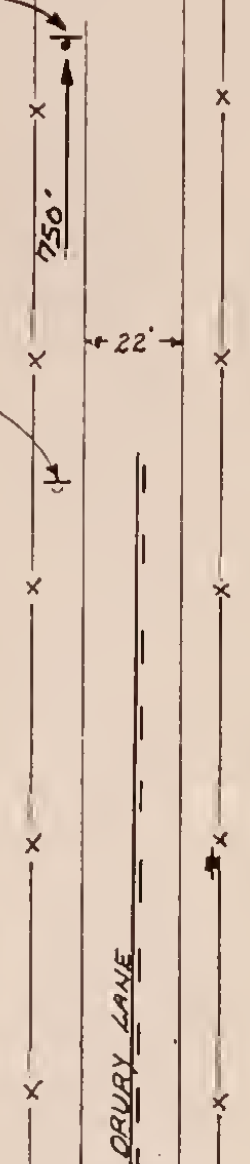
NEW 36"x36"
W3-1a



REMOVE



24"x24"
A85' FROM
INTERSECTION



DRURY LANE

ALFALFA

NEW 36"x36"
RI-1



REMOVE

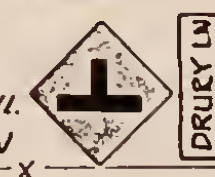


PASTURE

PASTURE

NEW PAVEMENT MARKINGS
EXTEND 500' ON ALL LEGS
PER M.U.T.C.D.

NEW 36"x36"
W2-4 & BULK/VEH.
ST. NAME SIGN



DRURY LN

220' HOSKINS RD.

150'
BRASS CAP

18"x84" CMP IRR.



48"x24" REMOVE & NEW W1-7

MAIL BOX

RESIDENCE

SCALE 1"=50'

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION :	DRURY LANE & HOSKINS ROAD				
	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
ACCIDENT TYPE	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	3	0	40%	1.2	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	1	0%	0.0	0.0
TOTALS :	3	1	***	1.2	0.0
% REDUCTION IN INJURY/FATAL ACCIDENTS =				40.0%	
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS =					0.0%

DRURY LANE AND HOSKINS ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	\$140.00	\$560.00
3	NEW SUPPLEMENTARY SIGNS	1	Ea	\$50.00	\$50.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	3	Ea	\$20.00	\$60.00
6	PAVE. MARKINGS (PAINT)	12	Gal	\$30.00	\$360.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	0	LS	\$0.00	\$0.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$1,030.00

MARVIN & ASSOCIATES
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS, MT 59107
Traffic Transportation & Civil Engineers
Ph. (406) 246-6066

Project: TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY

Sheet Title: DRURY LANE & HOSKINS ROAD
SHORT TERM IMPROVEMENTS

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Revisions
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No. _____
Sheet No. 1
of 1

S I T E N U M B E R 6

72ND ST. WEST & LAUREL AIRPORT ROAD PRIORITY NUMBER 6

SITE DESCRIPTION

Seventy Second Street West is a north-south arterial road located approximately six miles west of Billings. It begins on the north at an intersection with King Avenue West and extends south 5.0 miles where it terminates at the East Laurel I-90 interchange. The intersection with Laurel Airport Road is 4.0 miles south of King Avenue West.

Laurel Airport road is an east-west arterial which begins north of Laurel, Montana near the airport and extends east 4.5 miles to 64th Street West, one mile east of the intersection with 72nd Street West.

Both roads serve the large farm community between Laurel and Billings. Seventy Second Street West also provides alternate access between Laurel, Interstate 90 and the west end of Billings.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the intersection are on 72nd St. W. are approximately 1% while Laurel Airport Road approaches have a sharp grade ramping up to the higher elevation of 72nd St. W.

Laurel Airport Road was built to typical county road standards while 72nd Street West is built to more current Secondary Highway standards. Power poles, trees and fences provide a fairly cluttered roadside environment an occasion to block the line of sight.

Traffic Control Devices. Existing pavement markings at this site are in fairly good shape. However, they do not meet the standards required by MUTCD nor the Montana Department of Highways for intersection striping. The only signing in the area are stops signs and stop ahead warning signs on the Laurel Airport Road approaches. The warning sign for the westbound approach has a small non standard sign attached to it which states "Drive Carefully" which is nebulous at best.

Traffic Volumes. Peak hour counts were taken during the evening peak (4-5 PM). By applying the appropriate factors, it was determined that the average daily traffic is approximately 1,980 on 72nd Street West and 1,000 on Laurel Airport Road.

Traffic Operations. Higher design standards and the predominance of through traffic on 72nd Street West contribute to higher vehicle speeds on that road. Approximately every mile there is an intersecting street, therefore it is difficult even for the familiar driver to discern the proper location of the intersecting road they desire to turn at. Since the southbound right turn movement onto Laurel Airport Road is significant, vehicle speeds approaching the turn are probably in excess of desirable due to indecision.

The eastbound approach to the intersection should be fairly obvious, but the proliferation of buildings and trees along the roadside as well as a clear horizon mask the appearance of the intersecting street.

The westbound approach has more obvious visual clues except that the warning sign and stop sign are hidden by trees. Also, the intersection landing is on a sharp upgrade which makes visibility and acceleration from the stop, difficult.

In general, the higher traffic volumes and speeds on 72nd Street West combined with lower speeds on the approach road and a lack of physical clues to the intersections presence provides potentially hazardous conditions for the unfamiliar driver.

Accidents. There were eleven accidents at this intersection during the reporting period. Four accidents occurred in both 1984 and 1985; one in 1986 and one in 1987. The predominant accident types were angle accidents and single vehicle accidents. The vast majority of accidents occurred in clear weather and on dry roads. The number of accidents occurring in the daylight and at night were about evenly split. Surprisingly, property damage accidents were more common than injury type accidents (64% vs. 36%). The angle accidents involved eastbound and southbound vehicles.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new larger stop ahead signs will provide added emphasis to the approaching intersection and replacement of the existing stop signs

will also provide extra emphasis. Stop ahead pavement markings should be used as extra insurance. This will supplement the pavement markings which should be upgraded to MUTCD standards.

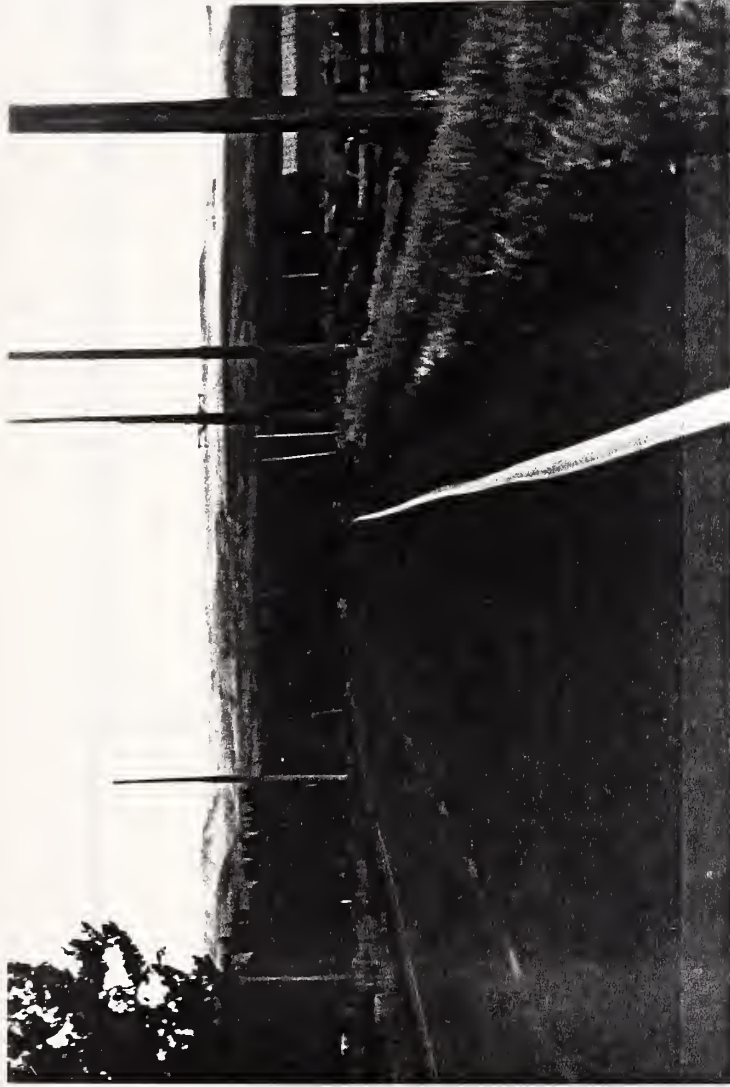
To improve information deficiencies on 72nd Street West, new intersection warning signs with the supplementary name plates should be located 750 feet from the intersection on both approaches.

The estimated cost of these improvements is \$2,270.00 based on 1988 unit bid contract prices.

Long term improvements should involve approach work on Laurel Airport Road to flatten the approach landings. A right turn lane for southbound to westbound turning traffic should be considered as a long term project, if total entering traffic at this intersection approaches 500 vph.

BENEFITS

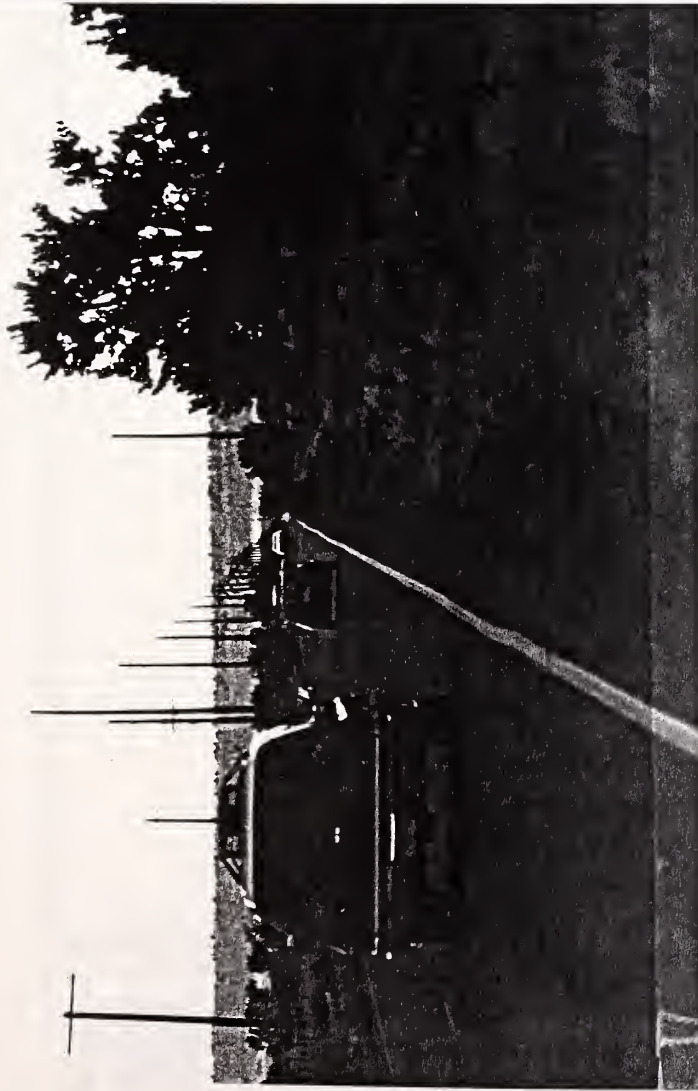
By improving driver expectancy, the single vehicle accident rate is expected to be reduced. The net benefit, according to stated methods, would be approximately \$ 10,099 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 14.45.



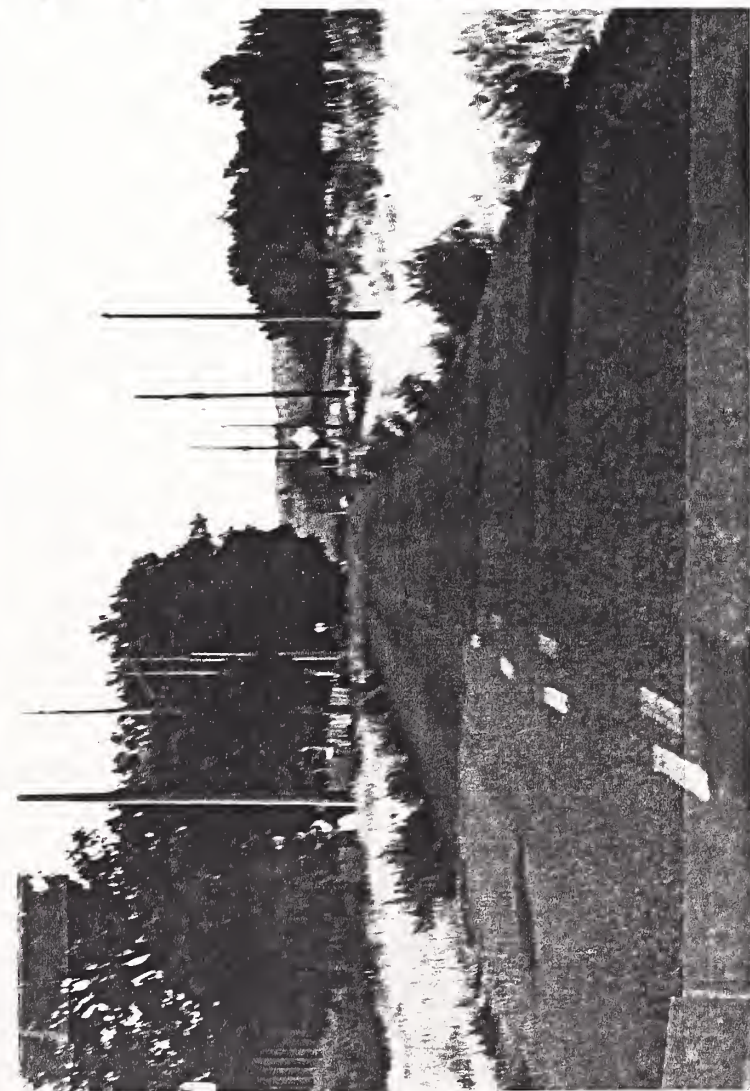
72ND STREET W. & LAUREL AIRPORT RD - SOUTHBOUND



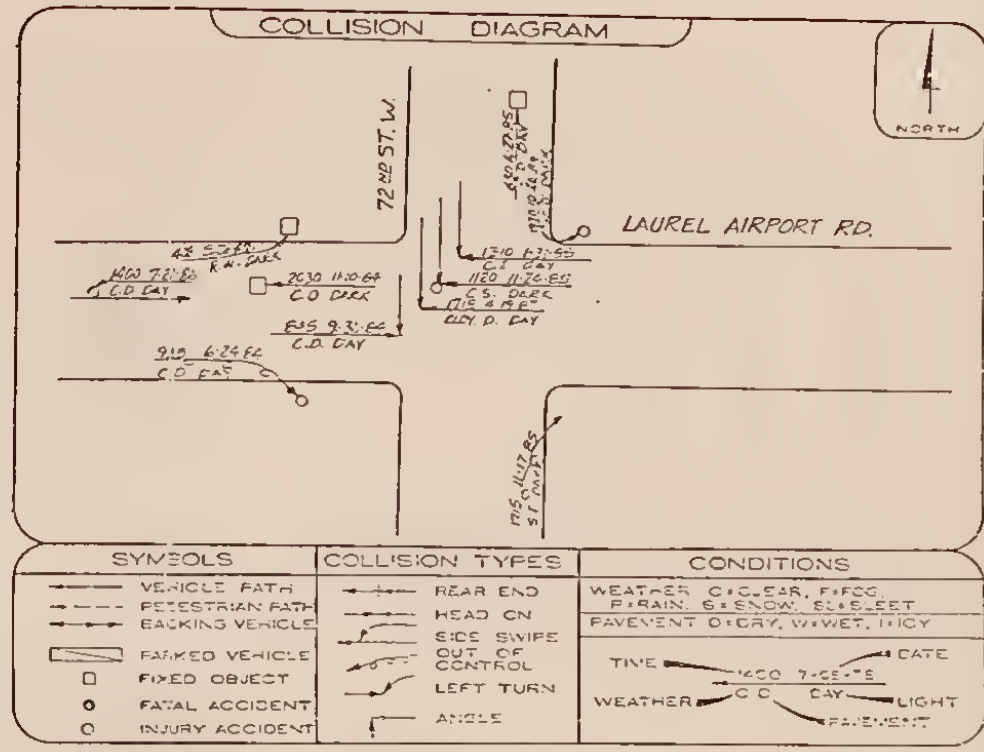
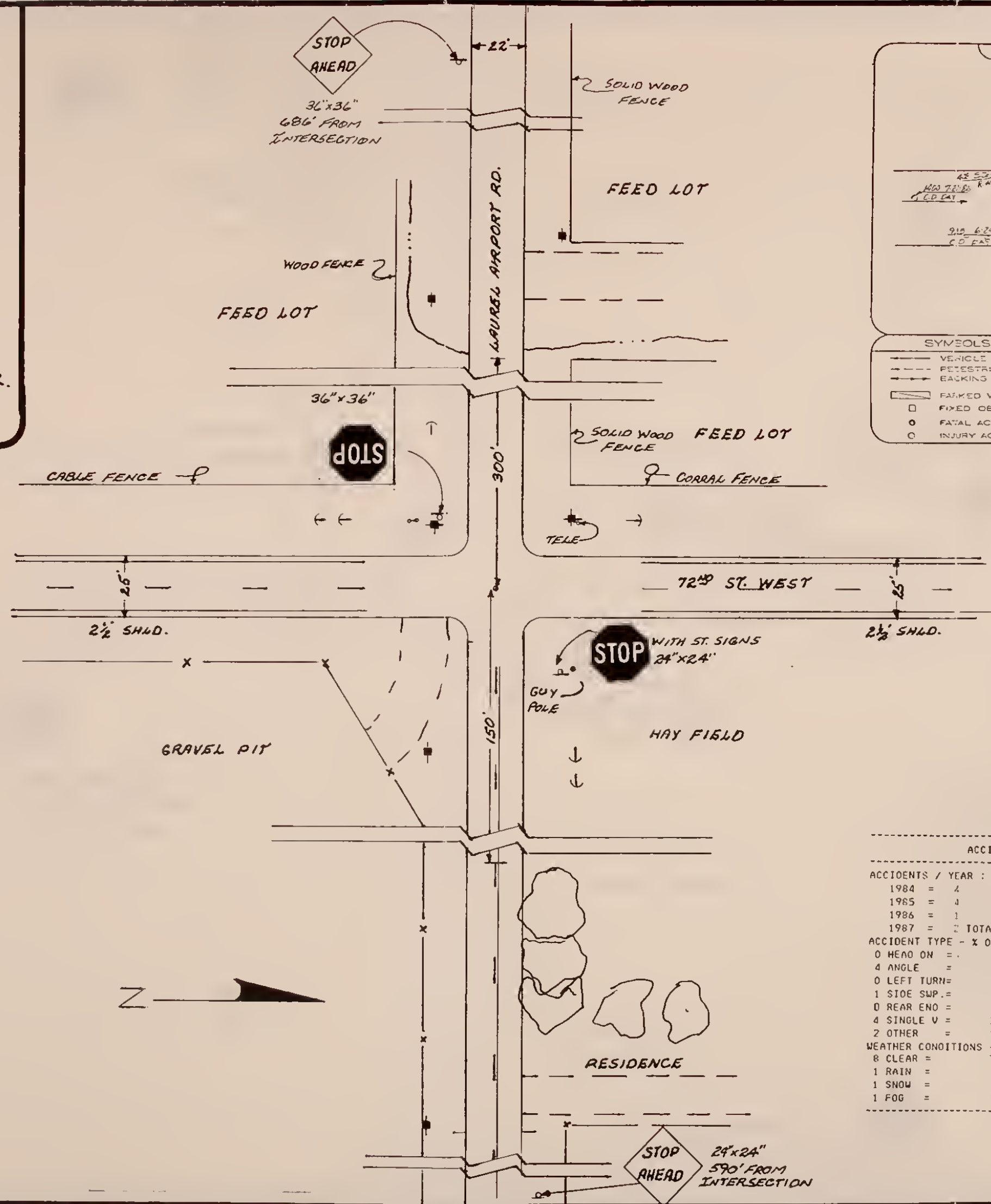
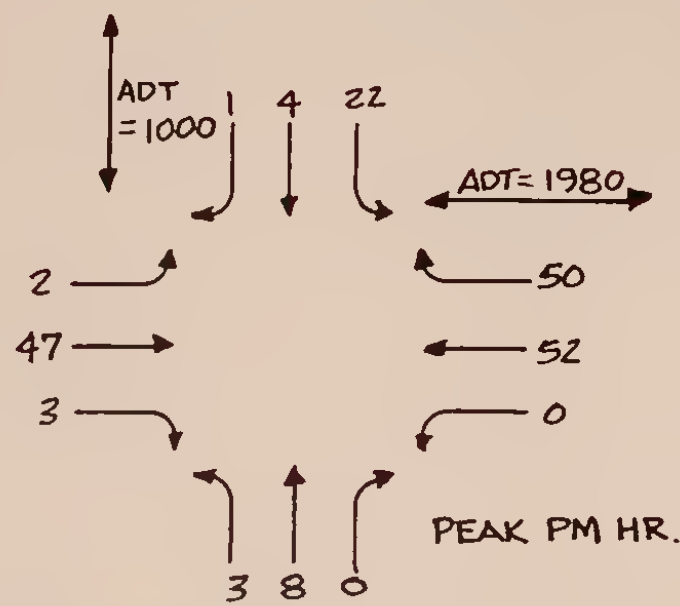
72ND STREET W. & LAUREL AIRPORT RD - WESTBOUND



72ND STREET W. & LAUREL AIRPORT RD - NORTHBOUND

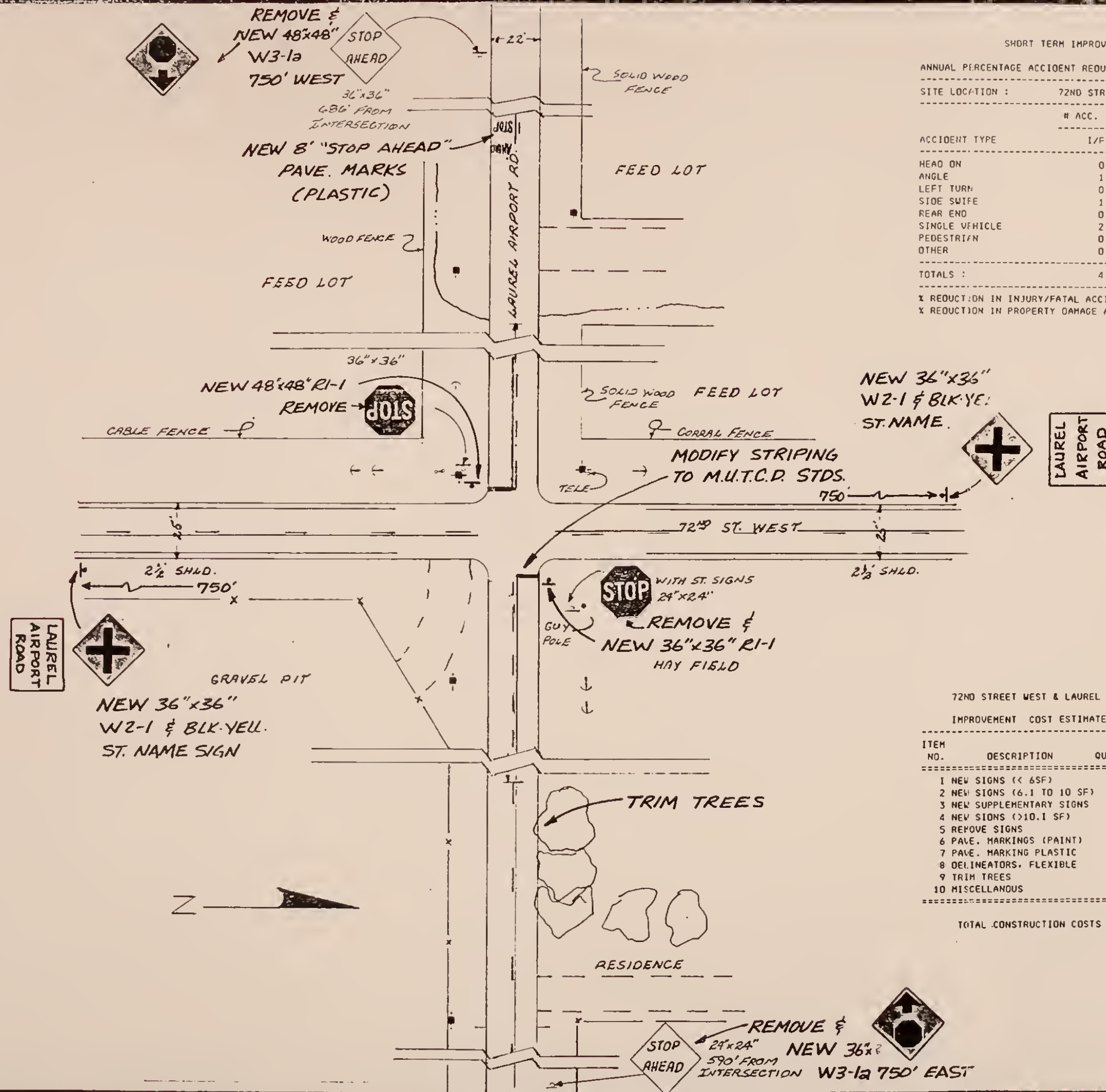


72ND STREET W. & LAUREL AIRPORT RD - EASTBOUND



ACCIDENT STATISTICS - 72ND ST. W. & LAUREL AIRPORT RD	
ACCIDENTS / YEAR :	ROAD CONDITIONS - % OF TOTAL :
1984 = 4	7 DRY = 64%
1985 = 4	1 WET = 9%
1986 = 1	3 ICY = 27%
1987 = 2 TOTAL = 11	LIGHT CONDITIONS - % OF TOTAL :
ACCIDENT TYPE - % OF TOTAL :	5 DARK = 45%
0 HEAD ON = 0%	6 DAY = 55%
4 ANGLE = 36%	SEVERITY - % OF TOTAL :
0 LEFT TURN = 0%	0 FATAL = 0%
1 SIDE SWP. = 9%	4 INJURY = 36%
0 REAR END = 0%	7 PROP DAM = 64%
4 SINGLE V = 36%	
2 OTHER = 18%	
WEATHER CONDITIONS - % OF TOTAL :	ALCOHOL INVOLVED 2
8 CLEAR = 73%	% TOTAL = 18%
1 RAIN = 9%	
1 SNOW = 9%	
1 FOG = 9%	

SCALE 1"=50'



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : 72ND STREET WEST & LAUREL AIRPORT ROAD

ACCIDENT TYPE	H ACC. IN PERIOD		EST. % CHANGE	CHANGE IN H ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	1	3	40%	0.4	1.2
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	1	0	20%	0.2	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	2	40%	0.8	0.8
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	2	20%	0.0	0.4
TOTALS :	4	7	***	1.4	2.4

% REDUCTION IN INJURY/FATAL ACCIDENTS = 35.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 34.3%

72ND STREET WEST & LAUREL AIRPORT ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGNS (6.1 TO 10 SF)	5	Ea	\$140.00	\$700.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	\$50.00	\$100.00
4	NEW SIGNS (>10.1 SF)	1	Ea	\$170.00	\$170.00
5	REMOVE SIGNS	4	Ea	\$20.00	\$80.00
6	PAVE. MARKINGS (PAINT)	15	Sq ft	\$30.00	\$450.00
7	PAVE. MARKING PLASTIC	45	SF	\$6.00	\$270.00
8	DELINEATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	1	LS	\$500.00	\$500.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$2,270.00

SCALE 1"=50'



MARVIN & ASSOCIATES

Traffic Transportation & Civil Engineers

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404 N 31st
BILLINGS MT 59107

Ph. (406) 248-6088

Project: TRAFFIC SAFETY STUDY-
YELLOWSTONE COUNTY

Sheet Title: 72ND ST. W. & LAUREL AIRPORT RD.
SHORT TERM IMPROVEMENTS

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

File name
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No.
Client No.

Sheet No.
1
of 1

S I T E N U M B E R 7

OLD BLUE CREEK ROAD

PRIORITY NUMBER 7

SITE DESCRIPTION

Old Blue Creek Road is a recreational access road which extends 1.5 miles from South Billings Boulevard east along the south side of the Yellowstone River. It access several residential dwellings and a motorcycle hill climb area. The cluster area is a stretch of road 0.2 to 0.7 miles east of South Billings Boulevard.

EXISTING CONDITIONS

Geometrics. Geometric features at the site are shown on the existing condition sketch. A series of horizontal and vertical curves comprise the section of road in question. Vertical grades vary between flat and 4%. This gravel road is similar in character to a mountain road in some areas. A steep hillside is adjacent to the road on the south side. The Yellowstone River is adjacent to it on the north side. Both sides of the road have steep banks.

Traffic Control Devices. The traffic control devices along this road consists of delineation (flexible delineators and chevron signs).

Traffic Volumes. manual traffic counts were taken at the site. It was determined that the average daily traffic is approximately 110 ADT. However, during the annual hill climb, volumes can reach into the hundreds of vehicles per hour.

Traffic Operations. Due to the low volume of traffic, it was not possible to draw any definitive conclusions regarding the operational characteristics of the roadway with respect to average driver behavior. Although, vehicles seen using the road tended to exceed what would normally be a reasonably prudent speed on the gravel surface. While conducting subjective index value studies on the site, it was determined that the roadway is a typical gravel mountain road. The first curves on the west side of the cluster site are not typical of what would be encountered on the remainder of the road and some speed adjustment is necessary to successfully negotiate the turns. The narrowest portion of the roadway is in this area. It appears that some attempts have been made to delineate this area since orange flagging has been tied between delineators.

Accidents. There were five accidents at this site. Two were in 1984 and 1 each in 1985, 1986 and 1987. All but one of the accidents were single vehicle accidents. The weather and roads were clear and dry in all cases. Sixty percent of the accidents were at night. Twenty percent of the accidents were injury type accidents. This also one of two study sites having a fatal accident. This involved a single vehicle leaving the roadway and entering the river.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. The improvements basically consist of warning signs, delineation and some curve widening.

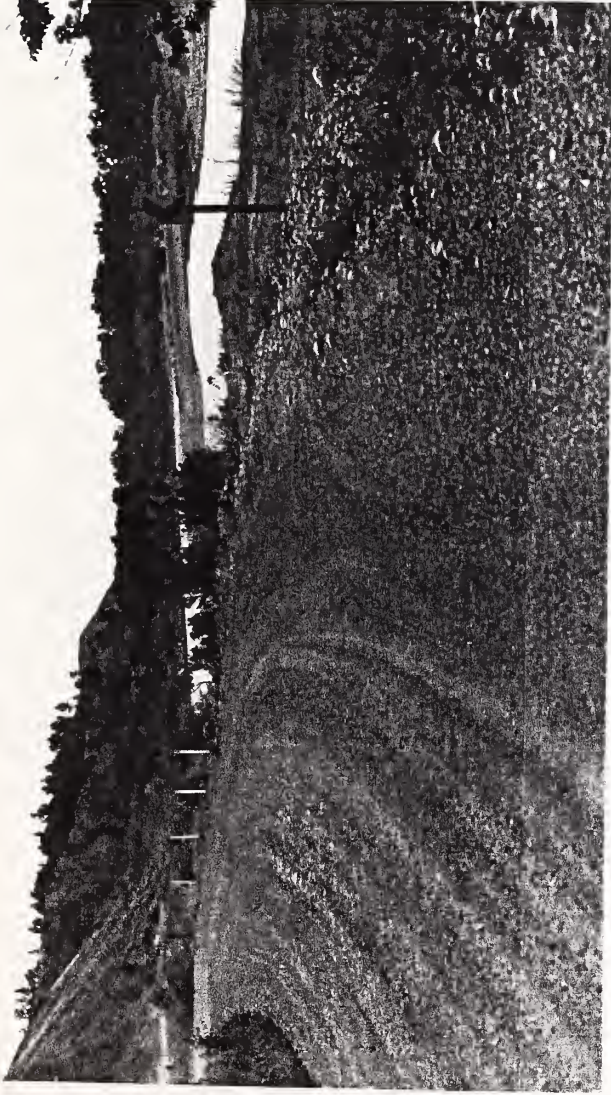
The main purpose of these recommendations is to increase the visibility of the vehicle travel path and provide advance warning which accurately reflects the conditions to be encountered. Curve widening is necessary to provide at least minimum room to maneuver within the road section.

The estimated cost of these improvements is \$7,670.00 based on 1988 unit bid contract prices.

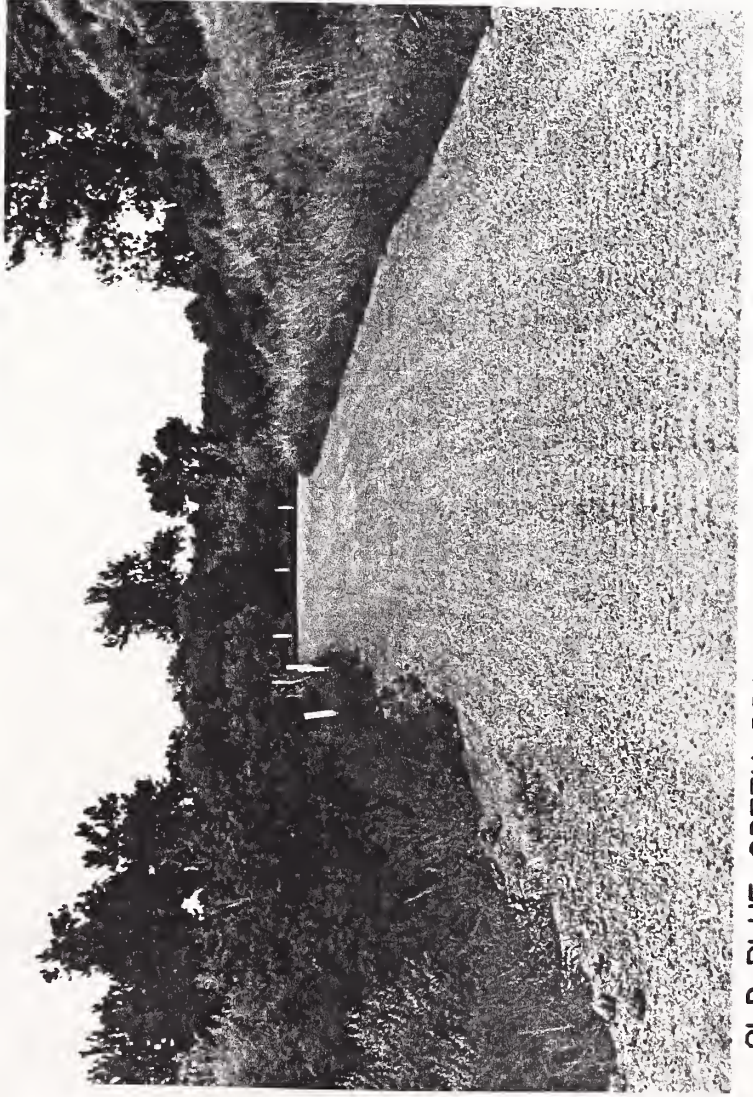
Long term improvements at this location cannot be anticipated due to the lack of foreseeable development that could occur and the extreme topographic constraints in this area.

BENEFITS

Improvements to advanced warning and delineation at this site may provide a significant reduction in accident experience. The net benefit, according to stated methods, would be approximately \$ 5,536 annually. The benefit/cost ratio at this sites calculated to be 4.26.



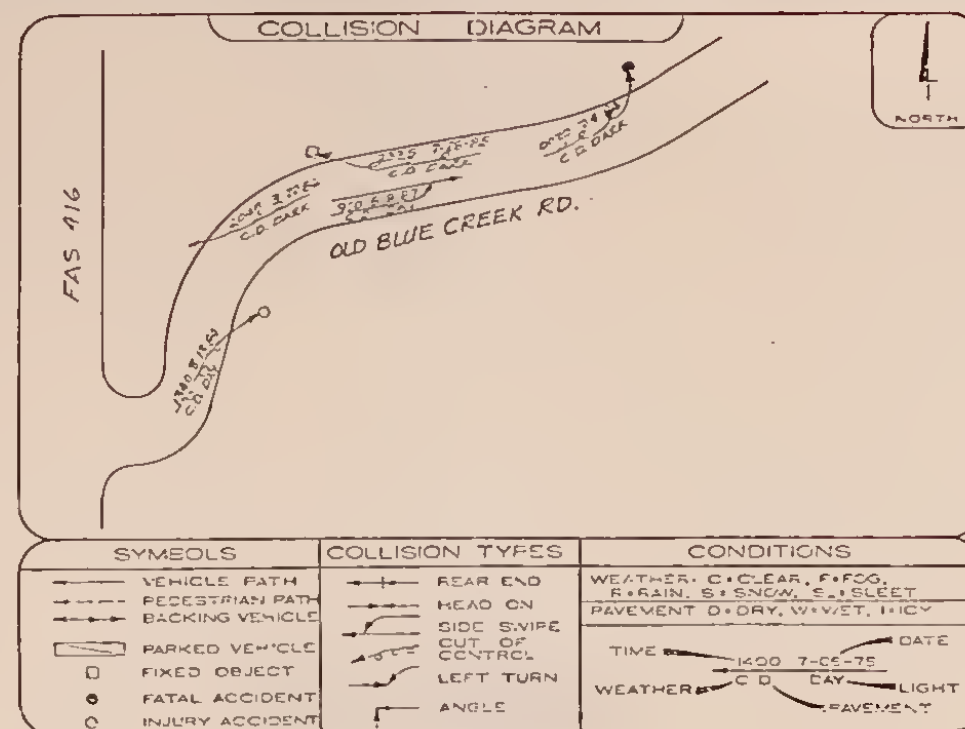
OLD BLUE CREEK ROAD, 0.7 MILES EAST - WESTBOUND



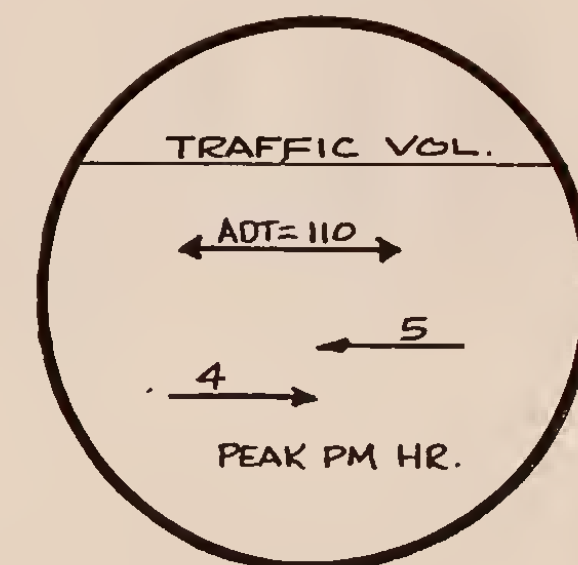
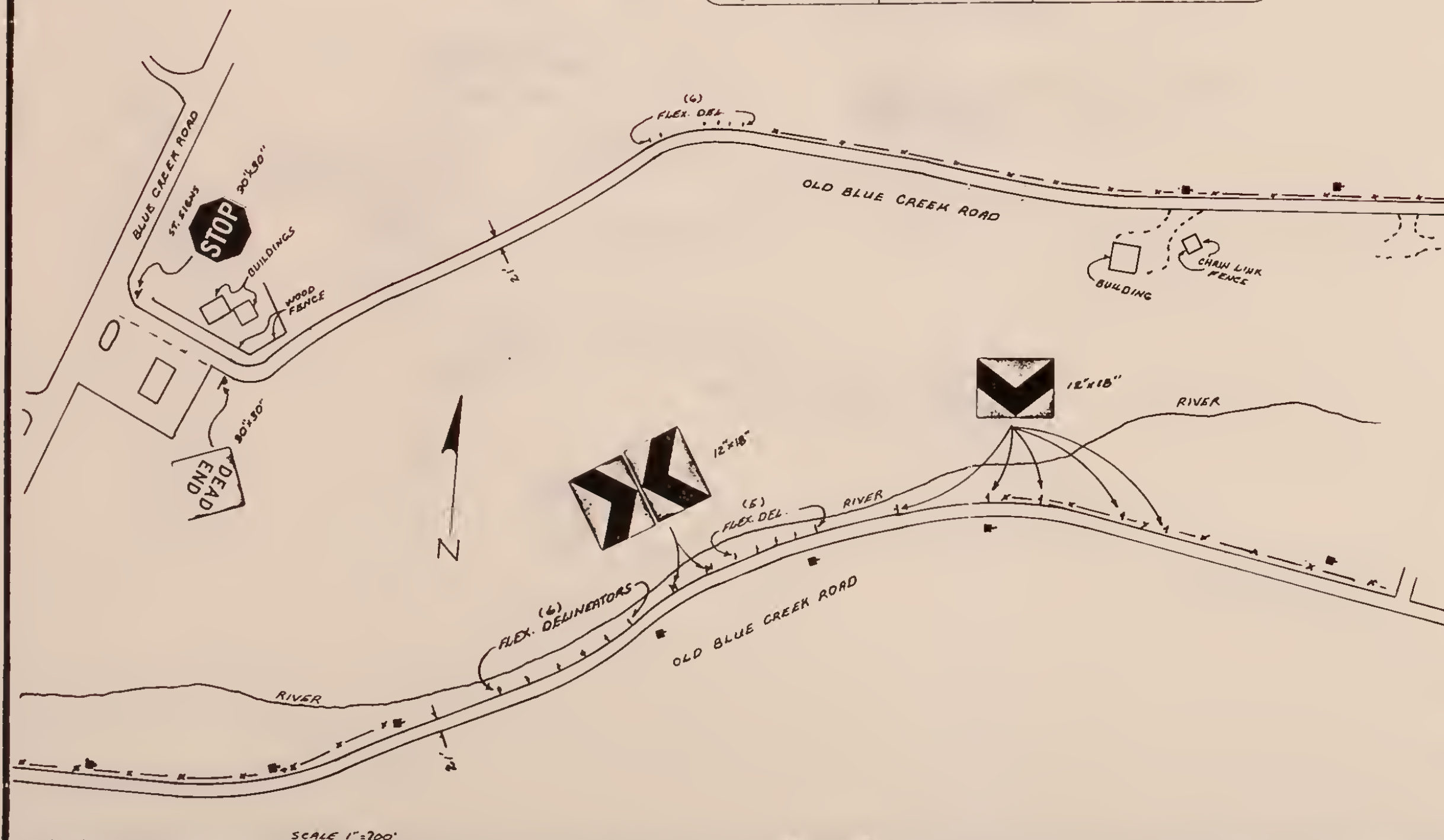
OLD BLUE CREEK ROAD, 0.2 MILES EAST - EASTBOUND



OLD BLUE CREEK ROAD, 0.2 MILES EAST - WESTBOUND



ACCIDENT STATISTICS -		OLD BLUE CREEK ROAD	
ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 = 2		5 DRY =	100%
1985 = 1		0 WET =	0%
1986 = 1		0 ICY =	0%
1987 = 1	TOTAL = 5	LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :		3 DARK =	60%
0 HEAD ON =	0%	2 DAY =	40%
0 ANGLE =	0%	SEVERITY - % OF TOTAL :	
0 LEFT TURN =	0%	1 FATAL =	20%
1 SIDE SWP. =	20%	1 INJURY =	20%
0 REAR END =	0%	3 PROP DAM =	60%
4 SINGLE V =	80%	ALCOHOL INVOLVED	
0 OTHER =	0%	3	
WEATHER CONDITIONS - % OF TOTAL :		% TOTAL =	
5 CLEAR =	100%	60%	
0 RAIN =	0%		
0 SNOW =	0%		
0 FOG =	0%		



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	1	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	2	40%	0.8	0.8
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	2	3	***	0.8	0.8

% REDUCTION IN INJURY/FATAL ACCIDENTS = 40.0%

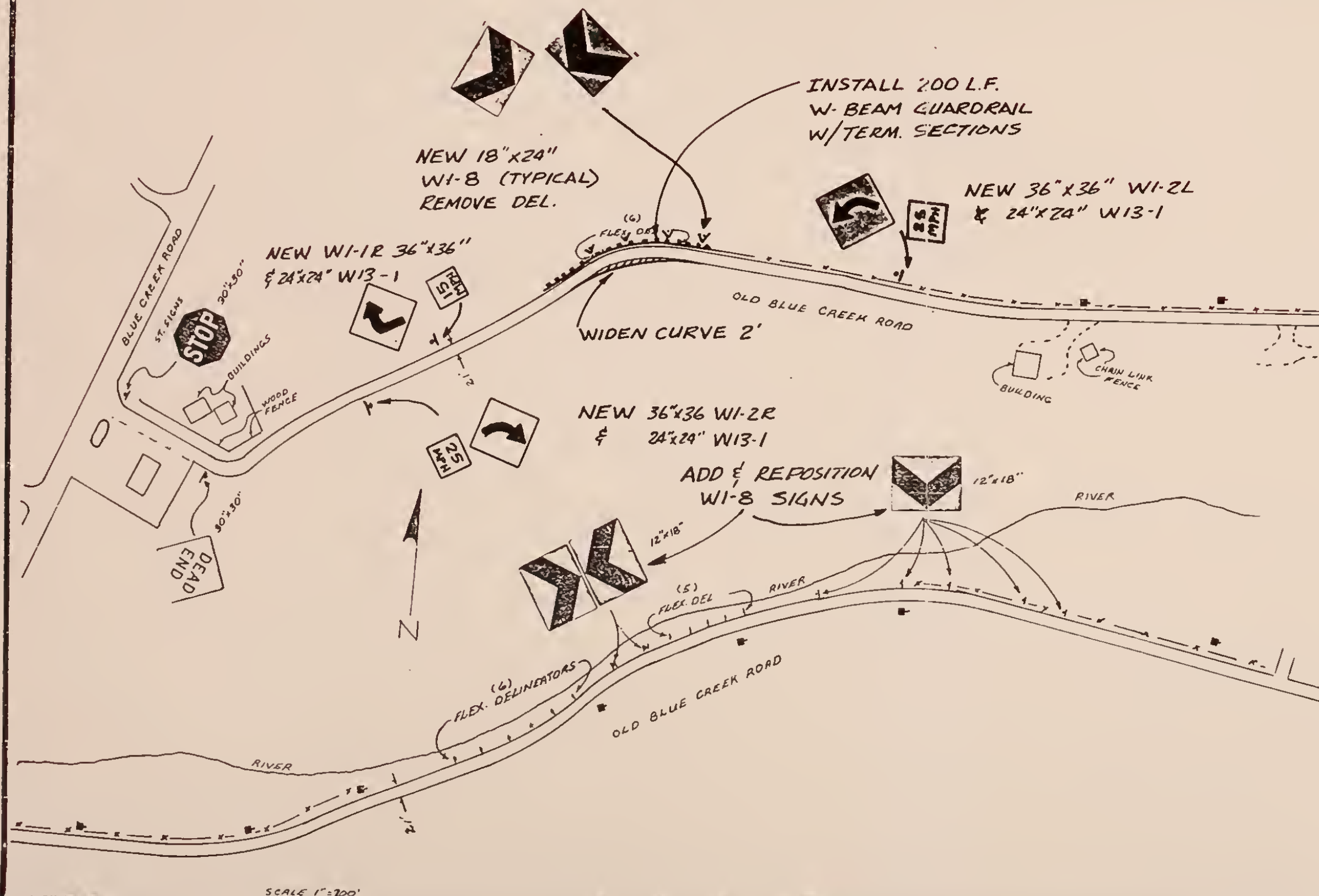
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 26.7%

OLD BLUE CREEK ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	12	Ea	\$100.00	\$1,200.00
2	NEW SIGNS (6.1 TO 10 SF)	3	Ea	\$140.00	\$420.00
3	NEW SUPPLEMENTARY SIGNS	3	Ea	\$50.00	\$150.00
4	RELOCATE SIGNS	5	Ea	\$40.00	\$200.00
5	REMOVE SIGNS	0	Ea	\$20.00	\$0.00
6	PAVE. MARKINGS (PAINT)	0	Gal	\$30.00	\$0.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	WIDEN CURVE	1	LS	\$2,500.00	\$2,500.00
9	W-BEAM GUARDRAIL	150	LF	\$8.00	\$1,200.00
10	W-BEAM TERM SECTION	2	Ea	\$1,000.00	\$2,000.00

TOTAL CONSTRUCTION COSTS = \$7,670.00



SITE

NUMBER

8

NEIBAUER & 48TH STREET WEST PRIORITY NUMBER 8

SITE DESCRIPTION

Neibauer Road is an east-west arterial which extends from Shiloh Road on the east to 80th Street West on the west terminus. Forty Eight Street West is a north-south arterial extending from Grand Avenue on the North to a point just north of Interstate 90 on the south. This intersection is located approximately 2.0 miles west of Billings. It is in a rural area with some residential development approximately 0.5 miles to the west. Most of the traffic served is rural residential and farm vehicles.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the intersection are less than 2% on all legs.

The property in the southwest quadrant of the intersection contains a metal fenced farm yard which tends to restrict sight distance to the west. A short jog in the approach alignment occurs on the northbound approach to the intersection. This area also has some large trees which tends to obscure the intersection.

Traffic Control Devices. Pavement markings at this site were striped during the county-wide striping program in 1986. Existing stripes are readily apparent but not consistent with M.U.T.C.D.

No signing other than stop signs with street name signs and advanced warning signs exist at this site.

Traffic Volumes. Peak hour counts were taken during the evening peak (4-5 PM). By applying the appropriate factors, it was determined that the average daily traffic is approximately 650 on Neibauer and 450 on 48th Street West.

Traffic Operations. It is apparent that the intersection violates driver expectancy and deficient information is provided. The physical features of the intersection are not visible until the vehicle is at the site which leaves no time to react. This deficiency exists for all approaches, but especially on the northbound approach.

Accidents. There was a total of 5 accidents at this site. One occurred in each year of 1984 thru 1986 and 2 happened in 1987. The predominant accident was the angle accident involving northbound and westbound traffic. The majority of accidents occurred on foggy or overcast days with dry roads. All of the accidents were in daylight hours. Two of the four angle accidents occurred when the sun would be setting in the west which would obstruct vision from glare. Injury and property damage accidents were split 40% - 60% respectively.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new stop ahead sign and replacement of the existing stop sign should greatly aid in improving the northbound accident problem. As additional reinforcement, it is recommended that the striping be modified at the intersection.

To improve information deficiencies on Neibauer, new intersection warning signs with the supplementary name plates should be located 750 feet from the intersection on both approaches. Weeds on the southwest corner of the intersection should be kept trimmed as well as trees along the northbound approach.

The estimated cost of these improvements is \$1,600.00 based on 1988 unit bid contract prices.

Long term improvements should include forcing the landowner in the southwest property to provide a setback on his fence. If this cannot be done, a new fence providing a line of sight through it should be constructed.

BENEFITS

By improving driver expectancy, the accident rate is expected to be reduced somewhat. The net benefit, according to stated methods, would be approximately \$ 5,700 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 10.92.



48TH STREET WEST & NEIBAUR - NORTHBOUND



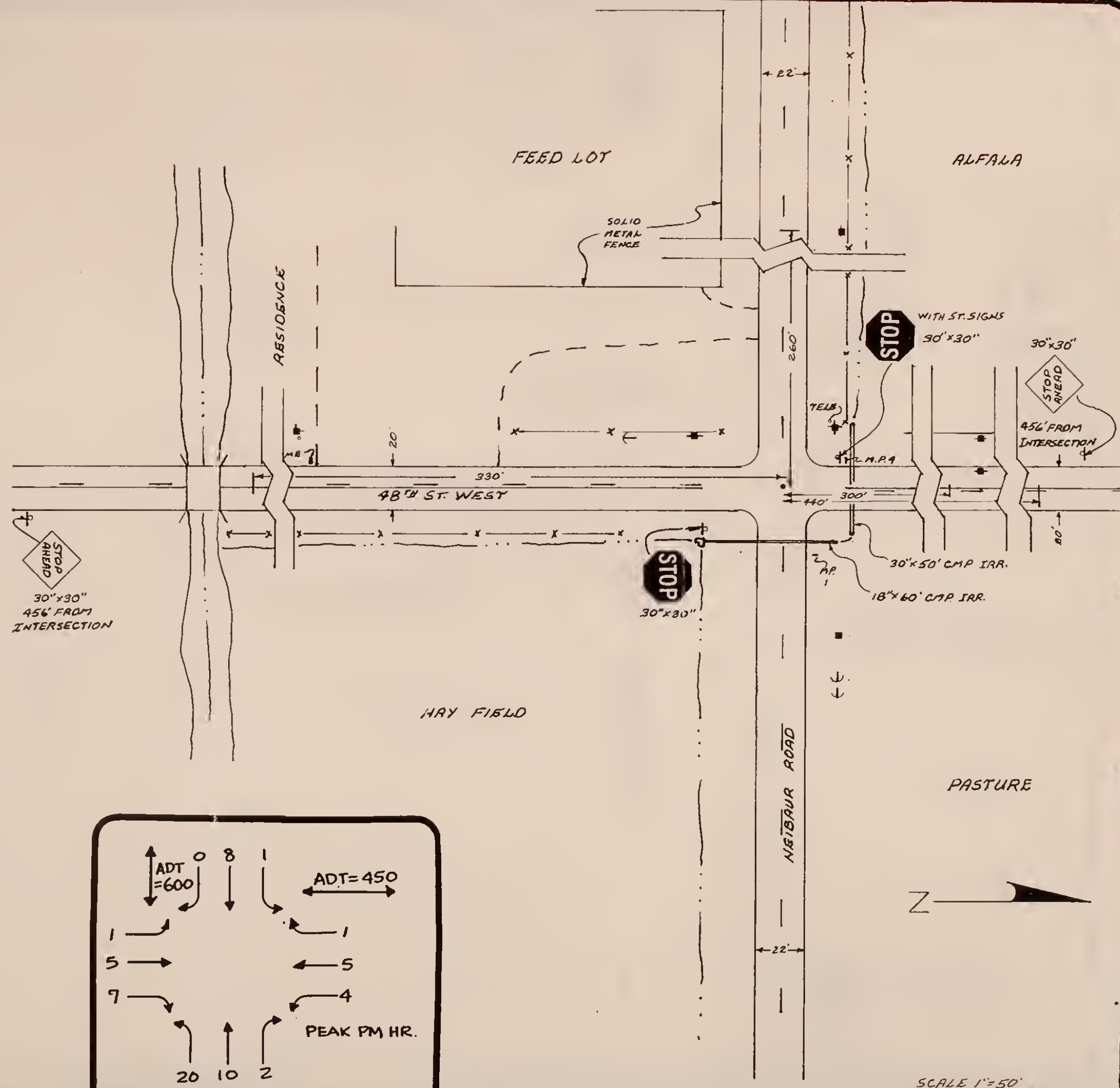
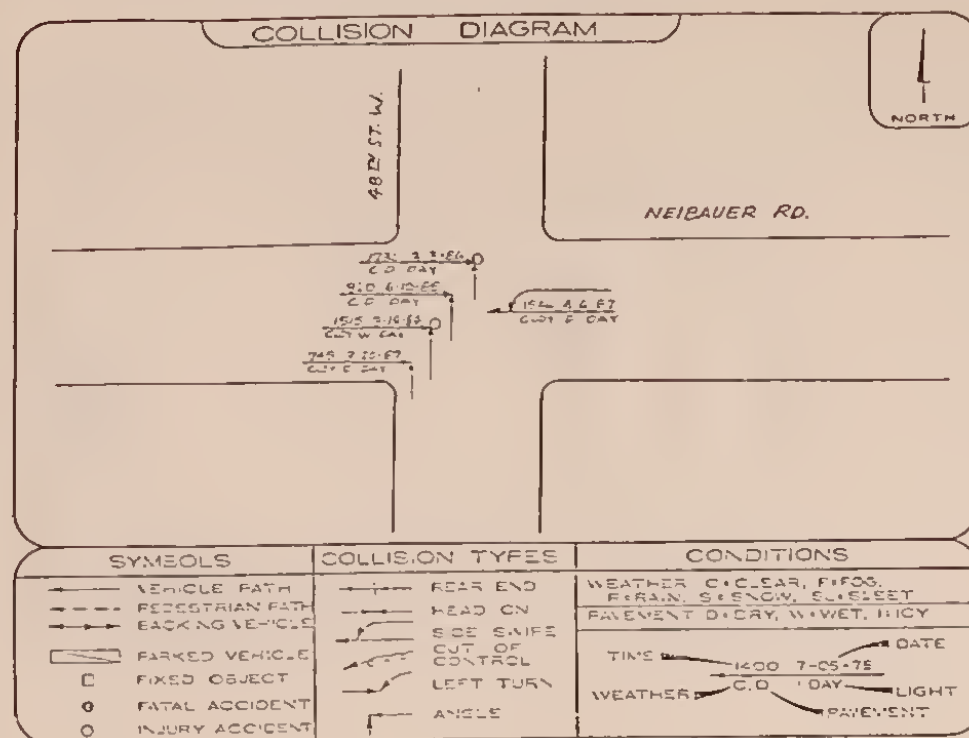
48TH STREET WEST & NEIBAUR - SOUTHBOUND



48TH STREET WEST & NEIBAUR - EASTBOUND



48TH STREET WEST & NEIBAUR - WESTBOUND



ACCIDENT STATISTICS -		NEIBAUER RD. - 48TH STREET W.	
ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 =	1	4 DRY =	80%
1985 =	1	1 WET =	20%
1986 =	1	0 ICY =	0%
1987 =	2	LIGHT CONDITIONS - % OF TOTAL :	
TOTAL = 5		0 DARK =	0%
ACCIDENT TYPE - % OF TOTAL :		5 DAY =	100%
0 HEAD ON =	0%	SEVERITY - % OF TOTAL :	
4 ANGLE =	80%	0 FATAL =	0%
0 LEFT TURN =	0%	2 INJURY =	40%
1 SIDE SWP. =	20%	3 PROP. DAM. =	60%
0 REAR END =	0%	ALCOHOL INVOLVED	
0 SINGLE V. =	0%	% TOTAL = 0%	
0 PEDEST. =	0%		
0 OTHER =	0%		
WEATHER CONDITIONS - % OF TOTAL :			
2 CLEAR =	40%		
0 RAIN =	0%		
0 SNOW =	0%		
3 FOG =	60%		



MARVIN & ASSOCIATES

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Project: **TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY**

Sheet Title: **NEIBAUER ROAD & 48TH ST. WEST
EXISTING CONDITIONS**

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Revisions
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No. _____
Client No. _____

Sheet No. **1**
of **1**

SHORT TERM IMPROVEMENTS

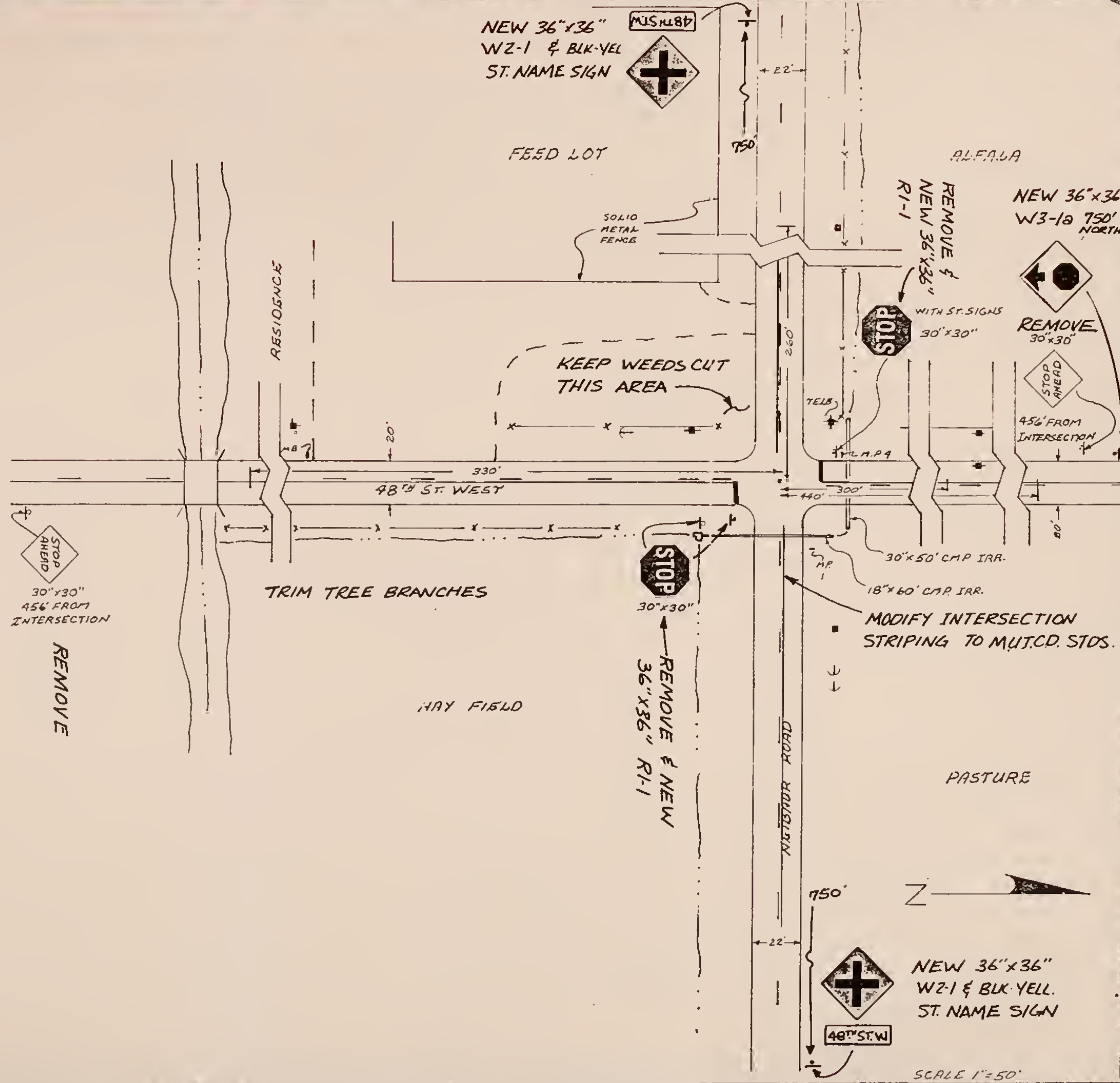
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : NEIBAUR & 48TH STREET WEST

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	2	2	40%	0.8	0.8
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	1	40%	0.0	0.4
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	0	0	0%	0.0	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	2	3	***	0.8	1.2

% REDUCTION IN INJURY/FATAL ACCIDENTS = 40.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 40.0%



NEW 36"x36"
W3-1a
750' NORTH

30"x30"
456' FROM
INTERSECTION

REMOVE

TRIM TREE BRANCHES

HAY FIELD

PASTURE

NEIBAUR & 48TH STREET WEST

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGNS (6.1 TO 10 SF)	6	Ea	\$140.00	\$840.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	\$50.00	\$100.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	4	Ea	\$20.00	\$80.00
6	PAVE. MARKINGS (PAINT)	6	Sa	\$30.00	\$180.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	1	LS	\$400.00	\$400.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$1,600.00

S I T E N U M B E R S

72ND STREET WEST @ RXR PRIORITY NUMBER 9

SITE DESCRIPTION

Seventy Second Street West is a north-south arterial road located approximately six miles west of Billings. It begins on the north at an intersection with King Avenue West and extends south 5.0 miles where it terminates at the East Laurel I-90 interchange. The railroad crossing is approximately 2,000 feet east of its southern terminus. It serves the large farm community between Laurel and Billings and also provides alternate access between Laurel, Interstate 90 and the west end of Billings. This roadway was built by the Montana Department of Highways as a Secondary Road.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the railroad crossing are approximately 1 percent. A steep downgrade (6%) for southbound traffic ends approximately 800 feet north of the tracks.

An extremely large, paved approach enters from the west approximately 250 feet north of the tracks. This approach serves a gravel pit to the west.

A sharp radius curve precedes the RXR on the south side. The curve was designed for 45 mph speeds.

A short section of guardrail is located on the east side of the roadway in the middle of the curve. The guardrail is provided to

protect errant vehicles from an irrigation canal which goes under the roadway.

A group of trees fill the area on the inside of the curve. These trees severely limit sight distance around the curve.

Traffic Control Devices. Existing pavement markings at this site are in fairly good shape. Signing in the area consists of advanced warning signs for the curve, the railroad crossing, the approach and even trucks entering. All of these signs are placed in poor locations. The warning signs order does not correspond to the order of conditions encountered.

The railroad crossing is protected by a RXR signal and cross arms. The railroad control shed for the signals is also placed right in the line of vision around the curve.

Traffic Volumes. Peak hour counts were taken during the evening peak (4-5 PM). By applying the appropriate factors, it was determined that the average daily traffic is approximately 1,800 on 72nd Street West.

Traffic Operations. Higher design standards and the predominance of through traffic on 72nd Street West contribute to higher vehicle speeds on that road. Southbound traffic has driven several miles on tangent roadway prior to encountering the sharp curve and complex geometrics. Even with warning signs, the curve is entirely unexpected.

Northbound traffic has the advantage of just entering the facility; they have not attained very great speeds ; and can see the curving road ahead. However, the RXR in the curve is entirely unexpected. Sight distance restrictions do not provide minimum stopping sight distance. Panic stops would be common when the railroad gate is down. The only visual clue would be the train itself.

Accidents. There were six accidents at this intersection during the reporting period. Four accidents occurred in 1984; none in 1985 or 1986 and two in 1987. The predominant accident types were fixed object (the railroad gates) and single vehicle accidents. The vast majority of accidents occurred in clear weather and on dry roads. The number of accidents occurring in the daylight and at night were evenly split. Property damage accidents were more common than injury type accidents. However, this is one of two sites that had a fatal accident.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new larger warning signs will provide added emphasis to the approaching conditions and command greater attention when located properly. Chevron signs will provide a missing visual clue as to the

sharpness of the curve especially for southbound traffic. The RXR pavement markings are required by MUTCD at all RXR that have a crossing gate.

Removal of the trees and other roadside sight obstruction are critical at this site. If nothing else were done at this location, removal of the sight restriction would significantly improve the safety.

The estimated cost of these improvements is \$4,960.00 based on 1988 unit bid contract prices.

Long term improvements should involve relocation of the railroad signal building to a location where it neither obstructs sight distance nor acts as a roadside hazard. If removal of all sight distance barriers cannot be accomplished, use of an advanced warning flasher which is wired into the railroad signal could be used for northbound traffic. This would gain at least 500 additional feet advanced warning that motorists would have to stop at the crossing.

BENEFITS

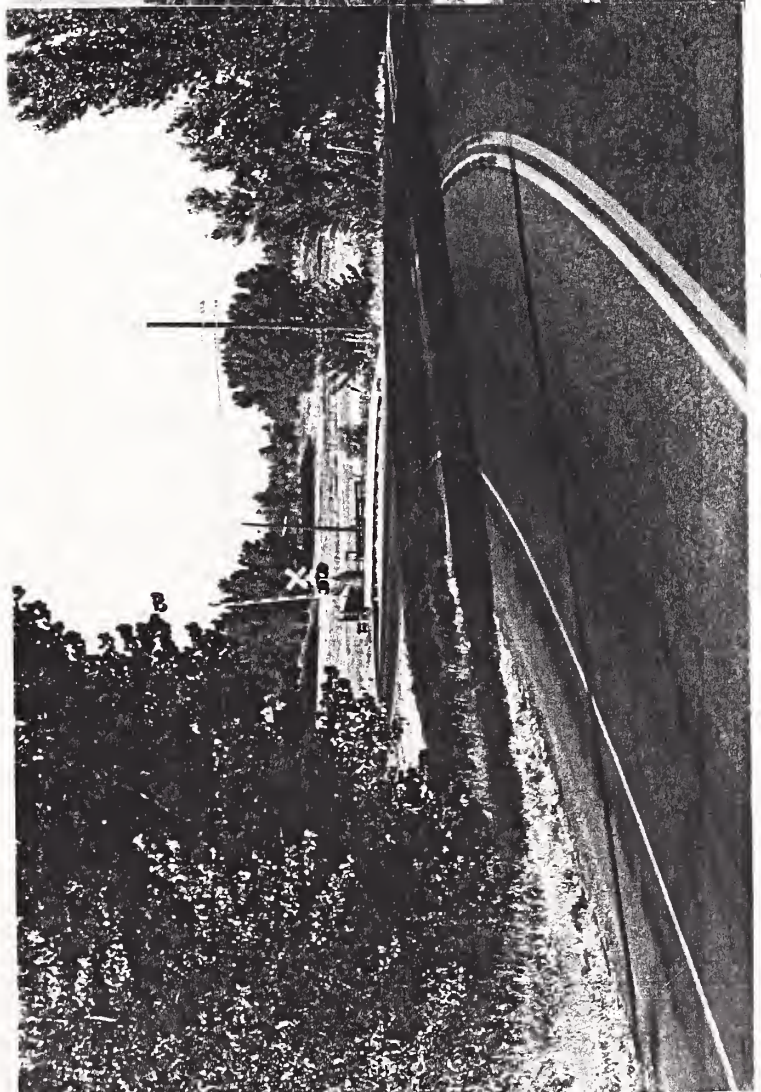
By improving driver expectancy, the accident rate is expected to be reduced somewhat. The net benefit, according to stated methods, would be approximately \$ 5,850 annually. The cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 4.15.



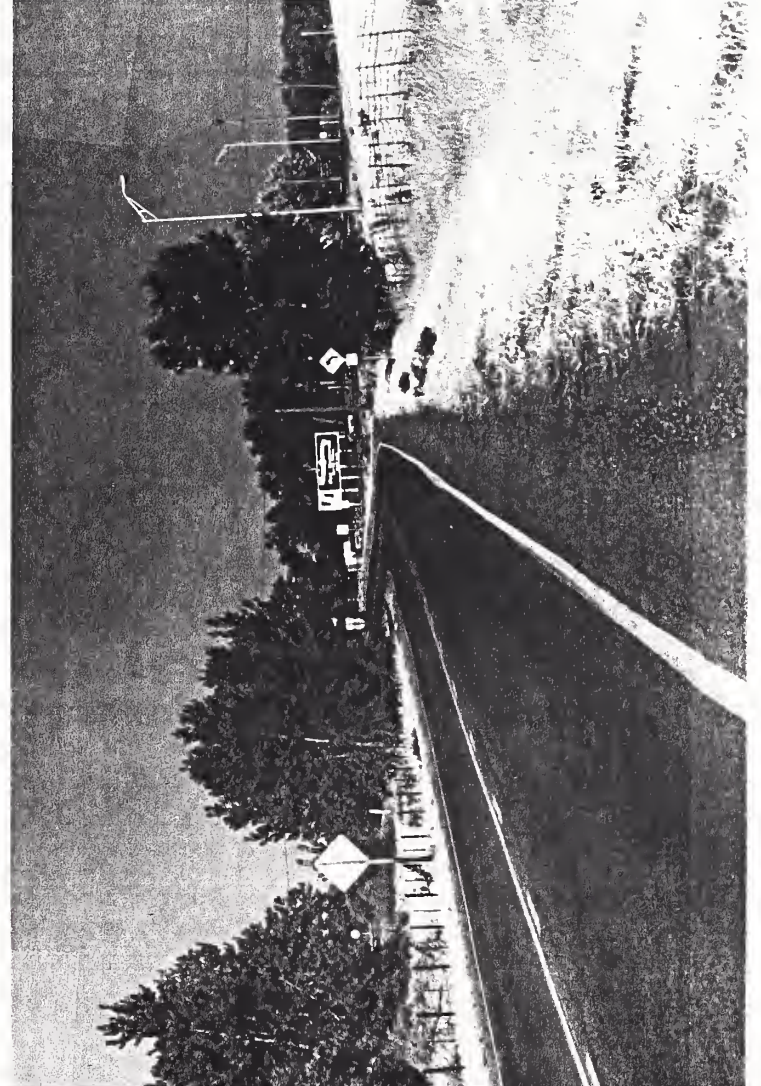
72ND STREET WEST - SOUTH BOUND



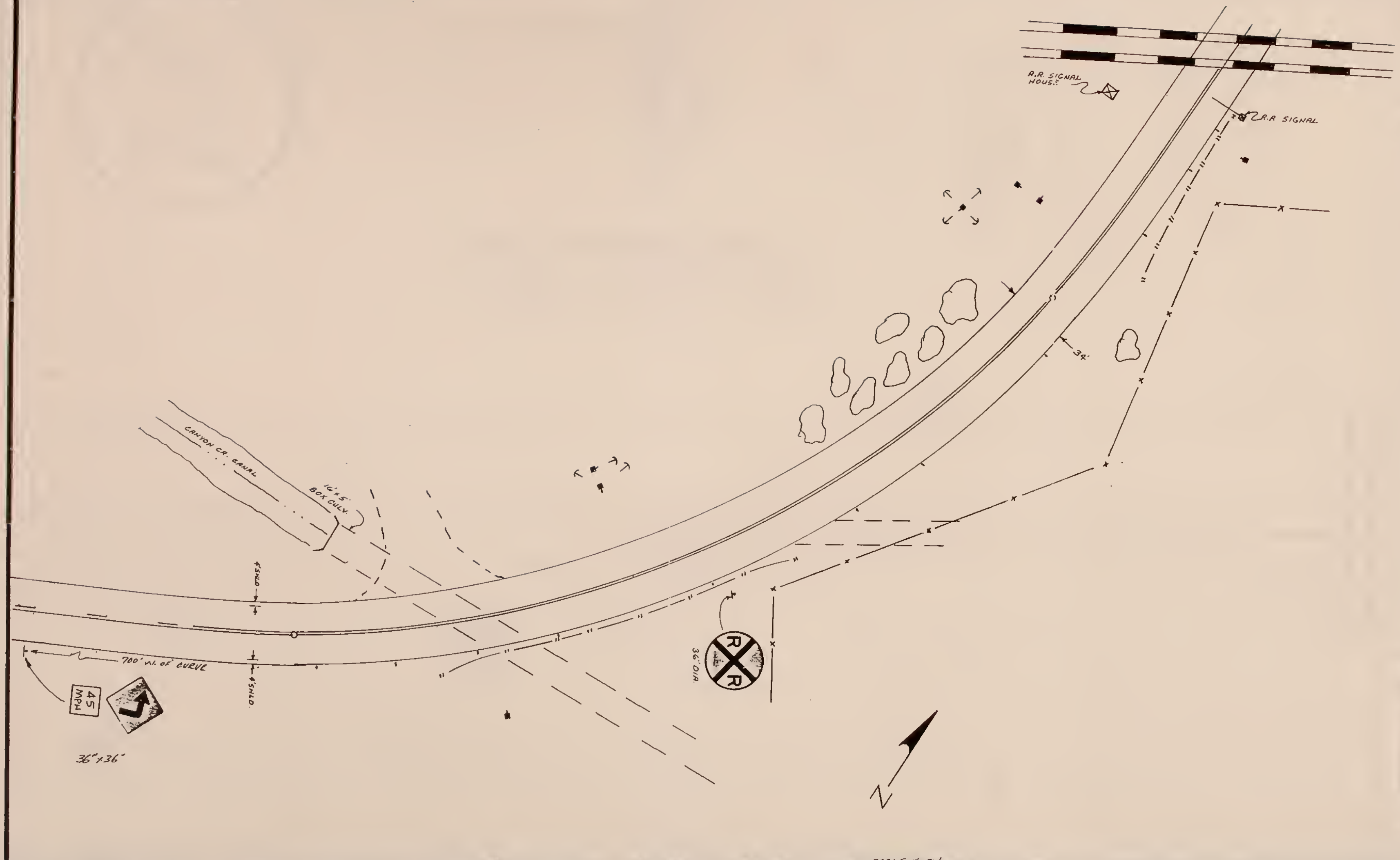
72ND STREET WEST - 1000 FEET NORTH

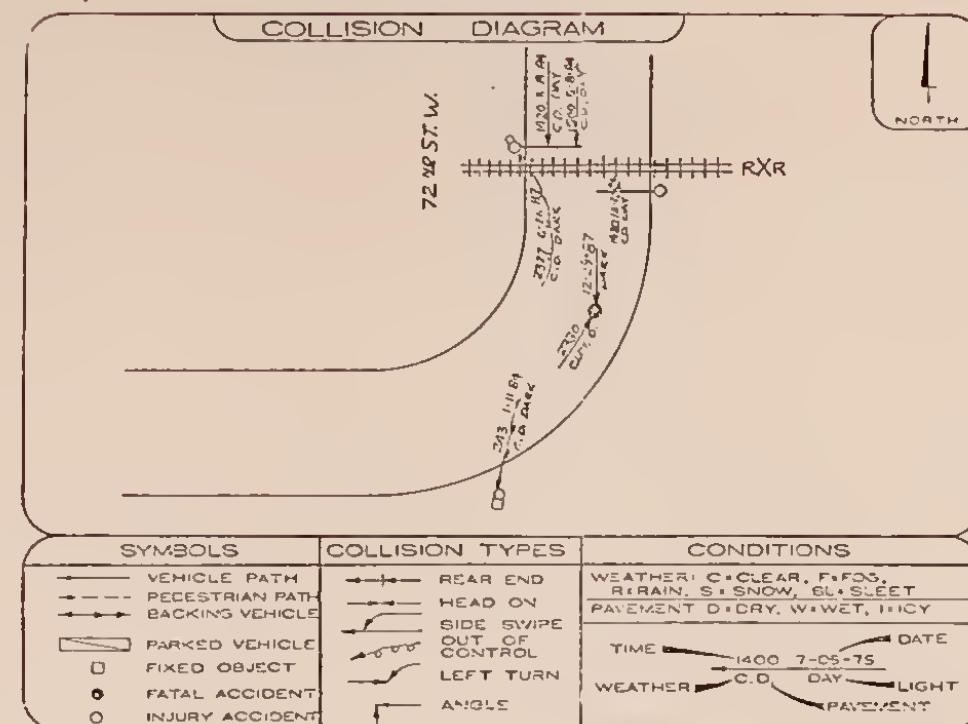
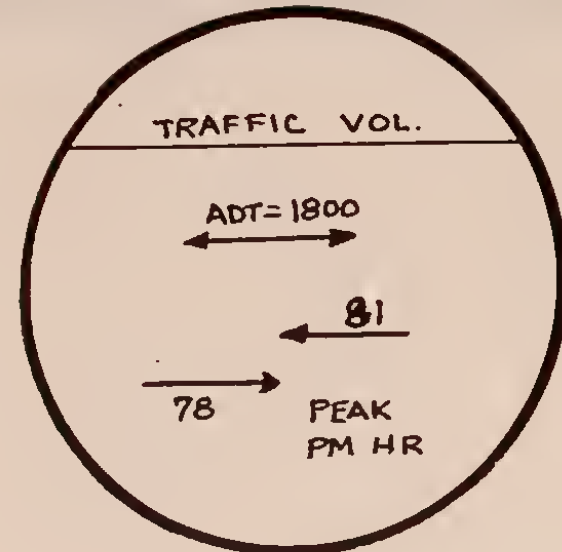


72ND STREET WEST - NORTH BOUND



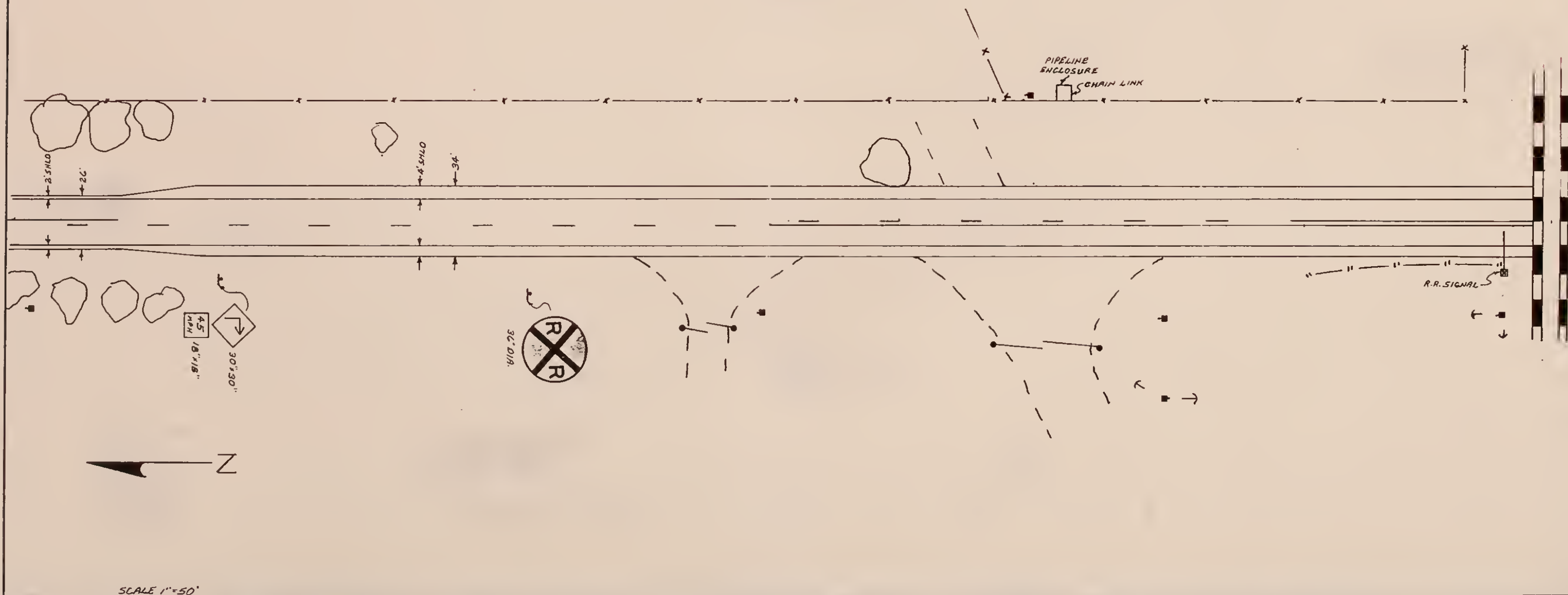
72ND STREET WEST - 1000 FEET WEST

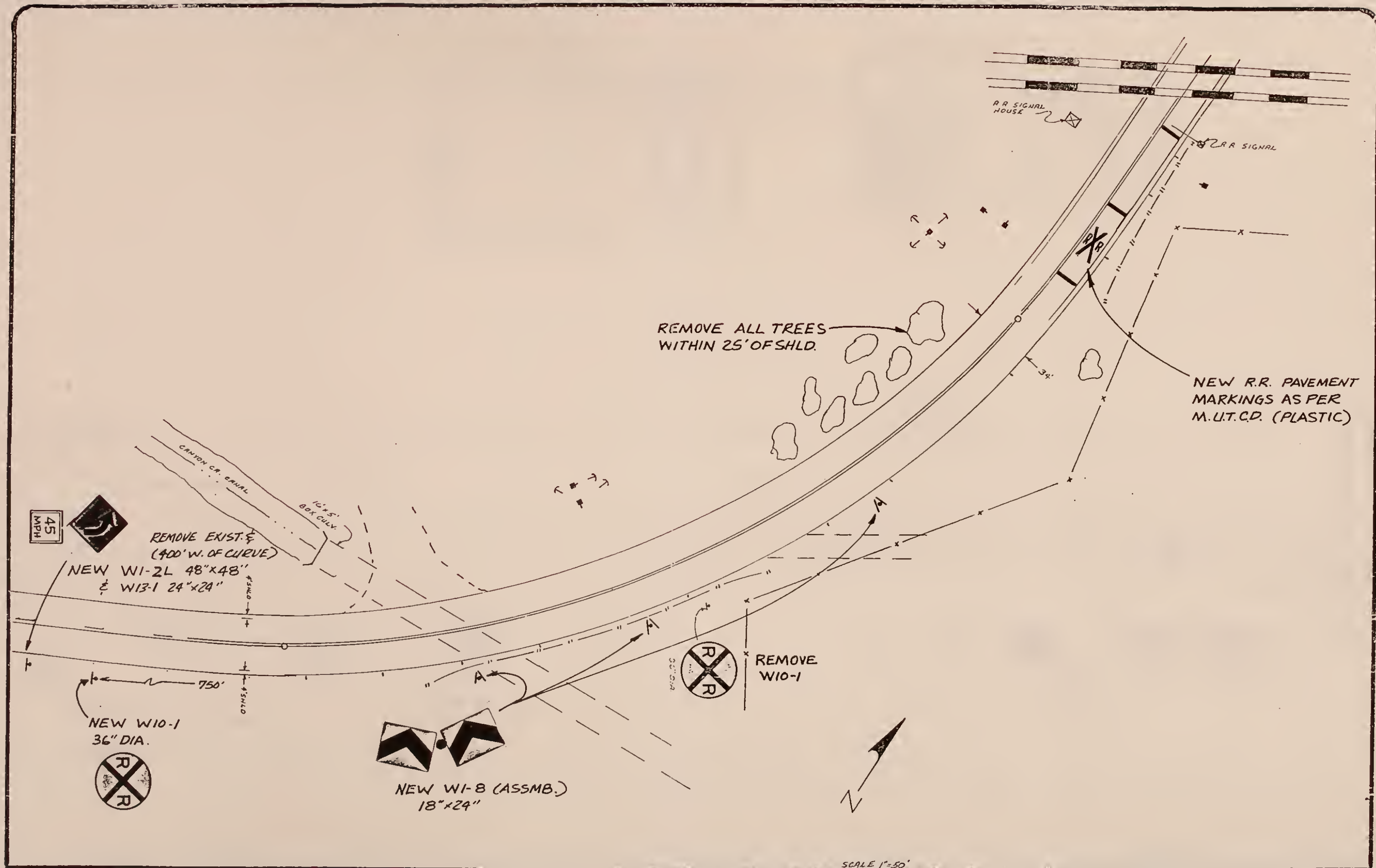




ACCIDENT STATISTICS - 72ND STREET WEST

ACCIDENTS / YEAR :	ROAD CONDITIONS - % OF TOTAL :
1984 = 4	6 DRY = 100%
1985 = 0	0 WET = 0%
1986 = 0	0 ICY = 0%
1987 = 2 TOTAL = 6	LIGHT CONDITIONS - % OF TOTAL :
ACCIDENT TYPE - % OF TOTAL :	3 DARK = 50%
1 HEAD ON = 17%	3 DAY = 50%
0 ANGLE = 0%	SEVERITY - % OF TOTAL :
0 LEFT TURN = 0%	1 FATAL = 17%
0 SIDE SWIPE = 0%	2 INJURY = 33%
0 REAR END = 0%	3 PROP OAH = 50%
2 SINGLE V = 33%	
0 PEDEST. = 0%	
3 OTHER = 50%	
WEATHER CONDITIONS - % OF TOTAL :	ALCOHOL INVOLVED 2
5 CLEAR = 83%	% TOTAL = 33%
0 RAIN = 0%	
0 SNOW = 0%	
1 FOG = 17%	





SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

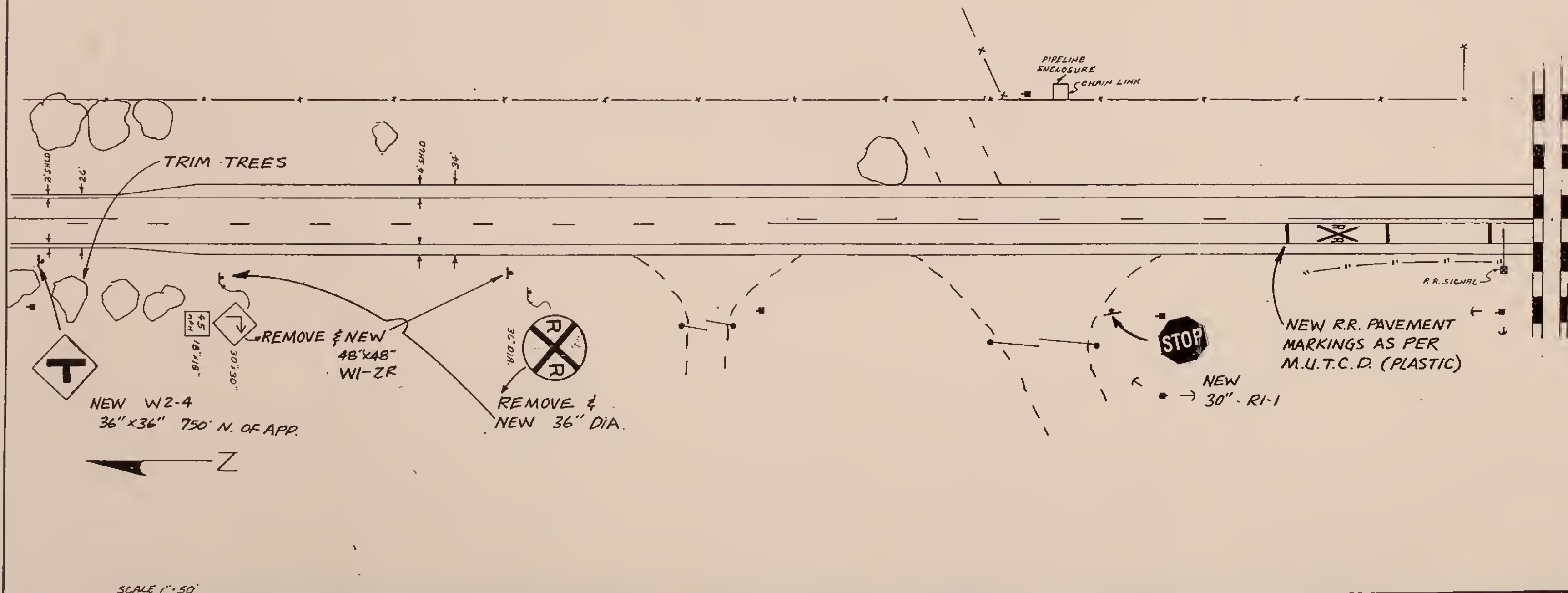
SITE LOCATION : 72ND STREET WEST R.R. CROSSING					
ACCIDENT TYPE	H ACC. IN PERIOD		EST. % CHANGE	CHANGE IN H ACC.	
	I/F	PD		I/F	PD
HEAD ON	1	0	10%	0.1	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	0	38%	0.8	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	3	20%	0.0	0.6
TOTALS :	3	3	***	0.9	0.6
% REDUCTION IN INJURY/FATAL ACCIDENTS =			28.7%		
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS =			20.0%		

72ND STREET WEST - RAILROAD X-ING

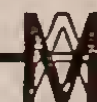
IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	7	Ee	\$100.00	\$700.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ee	\$140.00	\$560.00
3	NEW SUPPLEMENTARY SIGNS	1	Ee	\$50.00	\$50.00
4	NEW SIGNS (> 10.1 SF)	1	Ee	\$170.00	\$170.00
5	REMOVE SIGNS	6	Ee	\$20.00	\$120.00
6	PAVE. MARKINGS (PAINT)	6	Gal	\$30.00	\$180.00
7	PAVE. MARKING PLASTIC	280	SF	\$6.00	\$1,680.00
8	DELINEATORS, FLEXIBLE	0	Ee	\$20.00	\$0.00
9	TRIM TREES	1	LS	\$1,500.00	\$1,500.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$4,960.00



SCALE 1"=50'



MARVIN & ASSOCIATES

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Project: **TRAFFIC SAFETY STUDY-
YELLOWSTONE COUNTY**

Sheet Title: **72ND ST. W. AT RR TRACKS**

SHORT TERM IMPROVEMENTS

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Revisions
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No. _____
Client No. _____

Sheet No.
2
of **2**

S I T E

N U M B E R

10

BLUE CREEK ROAD & PRYOR ROAD PRIORITY NUMBER 10

SITE DESCRIPTION

Blue Creek Road is a Secondary type Highway which starts 2.0 miles south of Billings as South Billings Boulevard, and extends to the south and east 11.0 miles to an intersection with Pryor Road. Pryor Road is a Secondary Highway which begins in Pryor, Montana and extends north to an intersection with U. S. 87 (old road to Hardin).

Both of these roads are regional collector roads which provides access to rural properties and small towns near Billings.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the "T" intersection are less than 1% on Pryor Road and approximately 3% on Blue Creek Road. Both roads are paved and the road cross section is typical of past Secondary Highway standards.

Traffic Control Devices. Pavement markings at this site were sparse on Pryor Road. Striping on Blue Creek Road is more highly visible. Signing consists of intersection warning signs, a stop sign on Blue Creek Road and barricades at the head of the "T".

The intersection warning sign on Blue Creek Road is misapplied according to MUTCD and the barricade presents more of a hazard than nothing at all. The barricade applies to roads that are closed, not non-existent roads.

Traffic Volumes. Peak hour counts were taken during the morning peak hour. By applying the appropriate factors, it was determined that the average daily traffic is approximately 720 on Pryor Road and 550 on Blue Creek Road.

Traffic Operations. Pryor Road is in a state of disrepair that indicates normal maintenance is not very frequent. Blue Creek Road has a consistent roadway surface with traffic control devices consistent with current Yellowstone County standards. The intersection area seems to have missed maintenance and signing updates for several decades. Driver expectancy on the approaches to this intersection is violated due mostly to the dated methods of signing.

Accidents. There were three accidents during the four year reporting period. One was in 1985 and two were in 1987. The predominant accident involved the single vehicles. Two of the accidents involved vehicle running through the "T", while the other accident involved a vehicle missing the curve south of the intersection. The severity of these accidents is low considering the relatively high speeds. Sixty seven percent of the accidents were injury type. All of the accidents happened on dry roads with clear weather conditions. All of them occurred at night.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting of sign replacements, new traffic control devices and pavement markings.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new stop ahead sign and relocation of the existing stop sign will provide enhanced awareness of the conditions and should greatly aid in reinforcing the drivers decision in adjusting approach speed. The existing "T" warning sign was used incorrectly according to MUTCD and probably gave conflicting or confusing messages to drivers. The barricades should be removed and replaced with the standard arrow panel. As additional reinforcement, it is recommended that the striping be modified at the intersection.

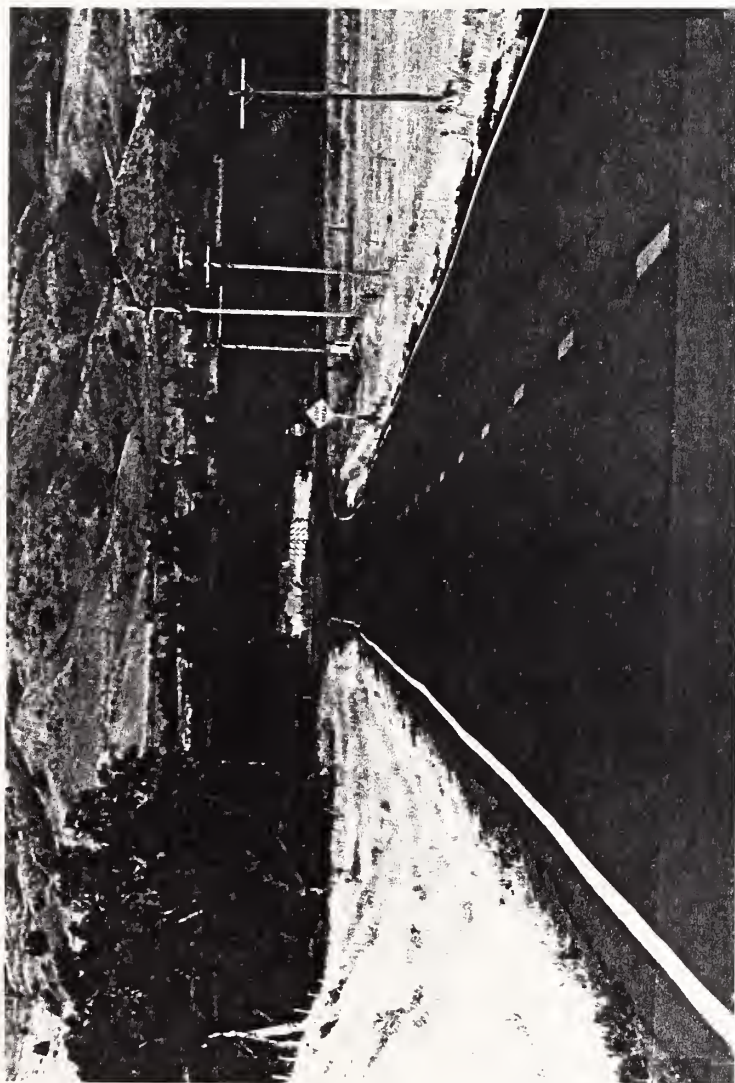
To improve information deficiencies for Pryor Road traffic, new intersection warning signs with the supplementary name plates should be located 750 feet from the intersection.

The estimated cost of these improvements is \$900.00 based on 1988 unit bid contract prices.

Long term improvements cannot be suggested at this point, since the degree of future traffic growth and the construction of alternate access facilities cannot be predicted with any certainty. It is assumed that volumes will not reach a critical stage within the next 20 years.

BENEFITS

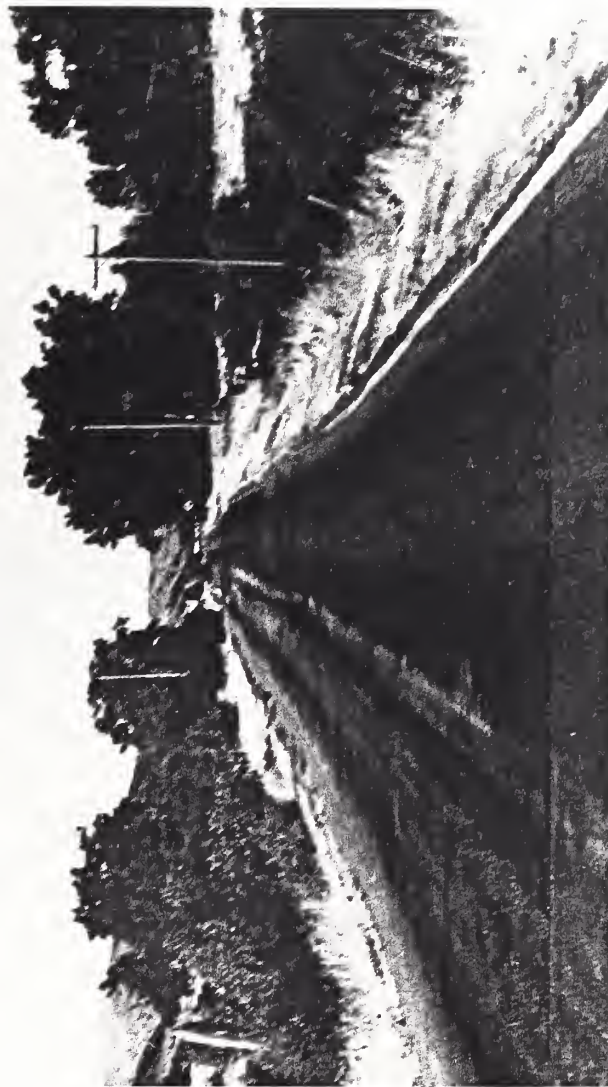
By improving driver expectancy, the single vehicle accident rate is expected to be reduced. The net benefit, according to stated methods, would be approximately \$ 4,699 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 16.35.



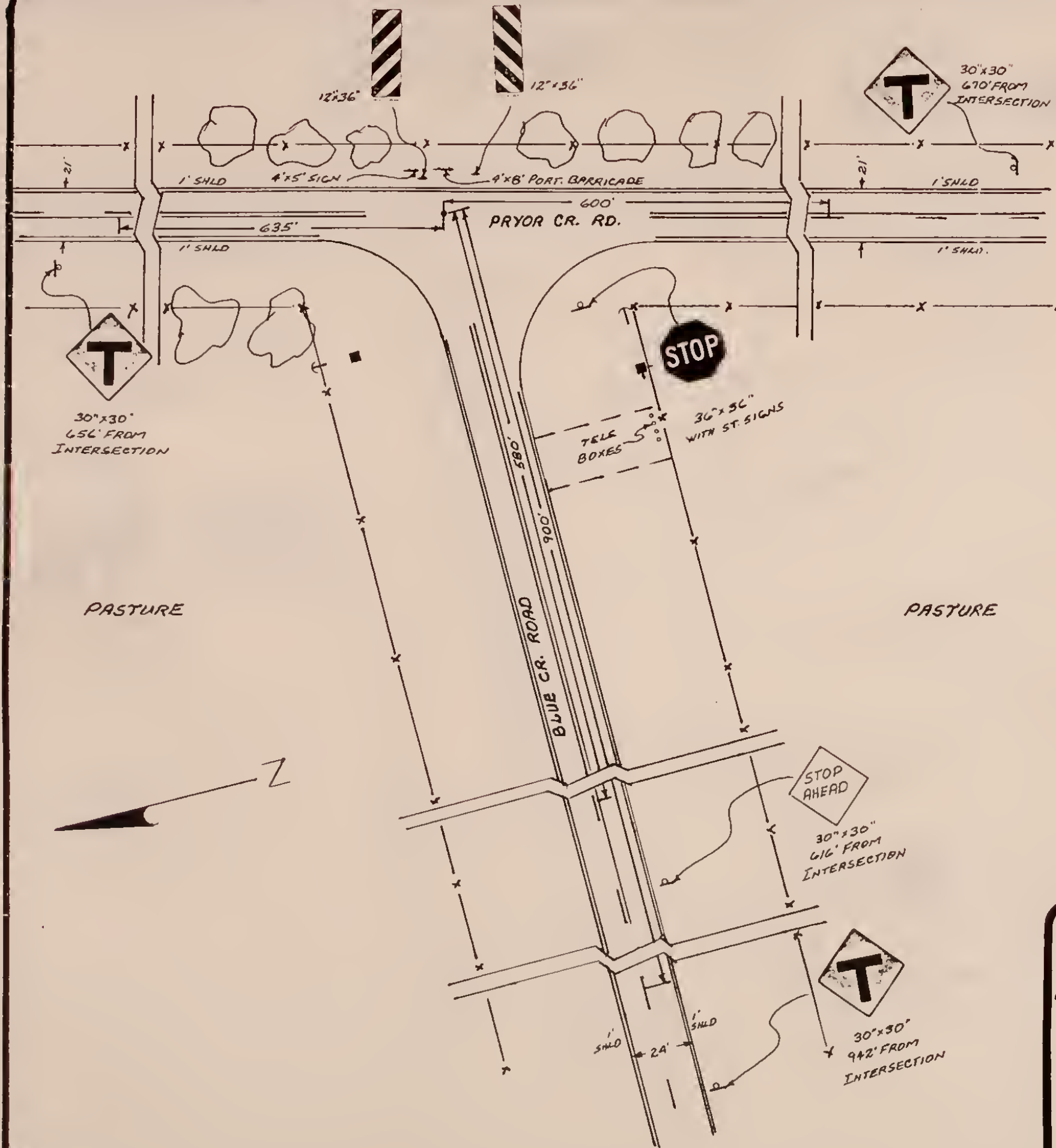
BLUE CREEK ROAD - EASTBOUND



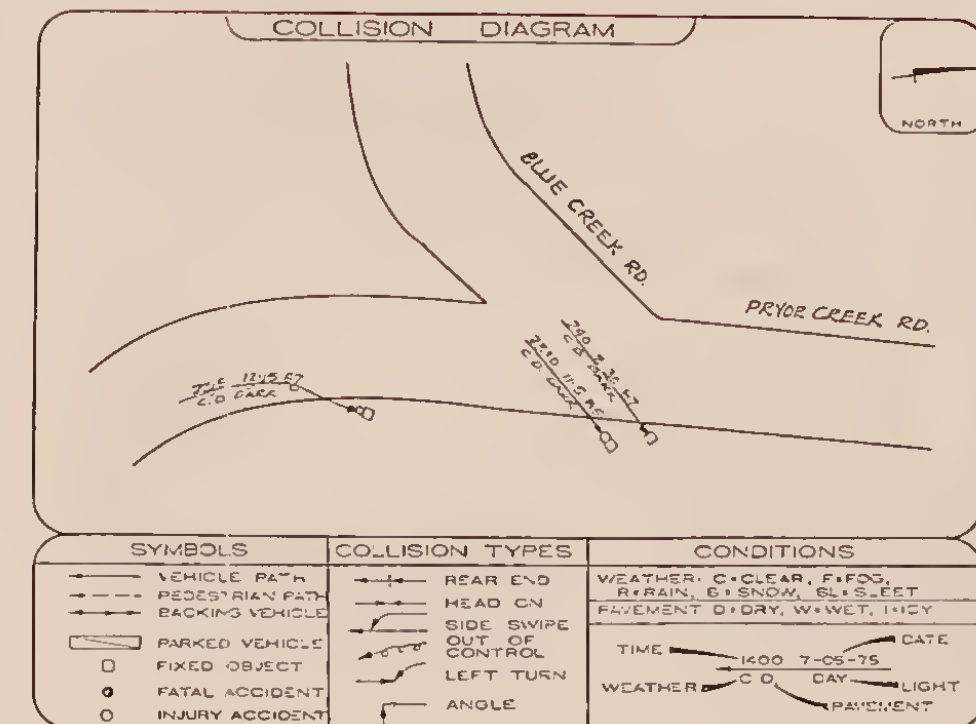
PRYOR CREEK ROAD - SOUTHBOUND



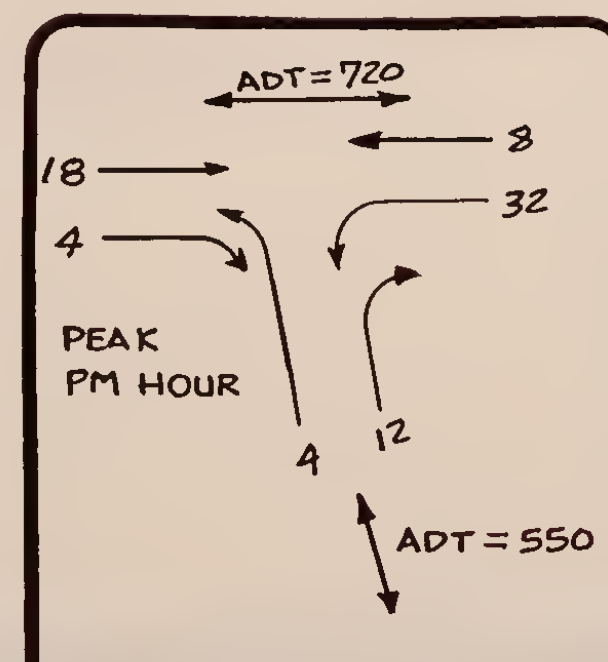
PRYOR CREEK ROAD - NORTHBOUND

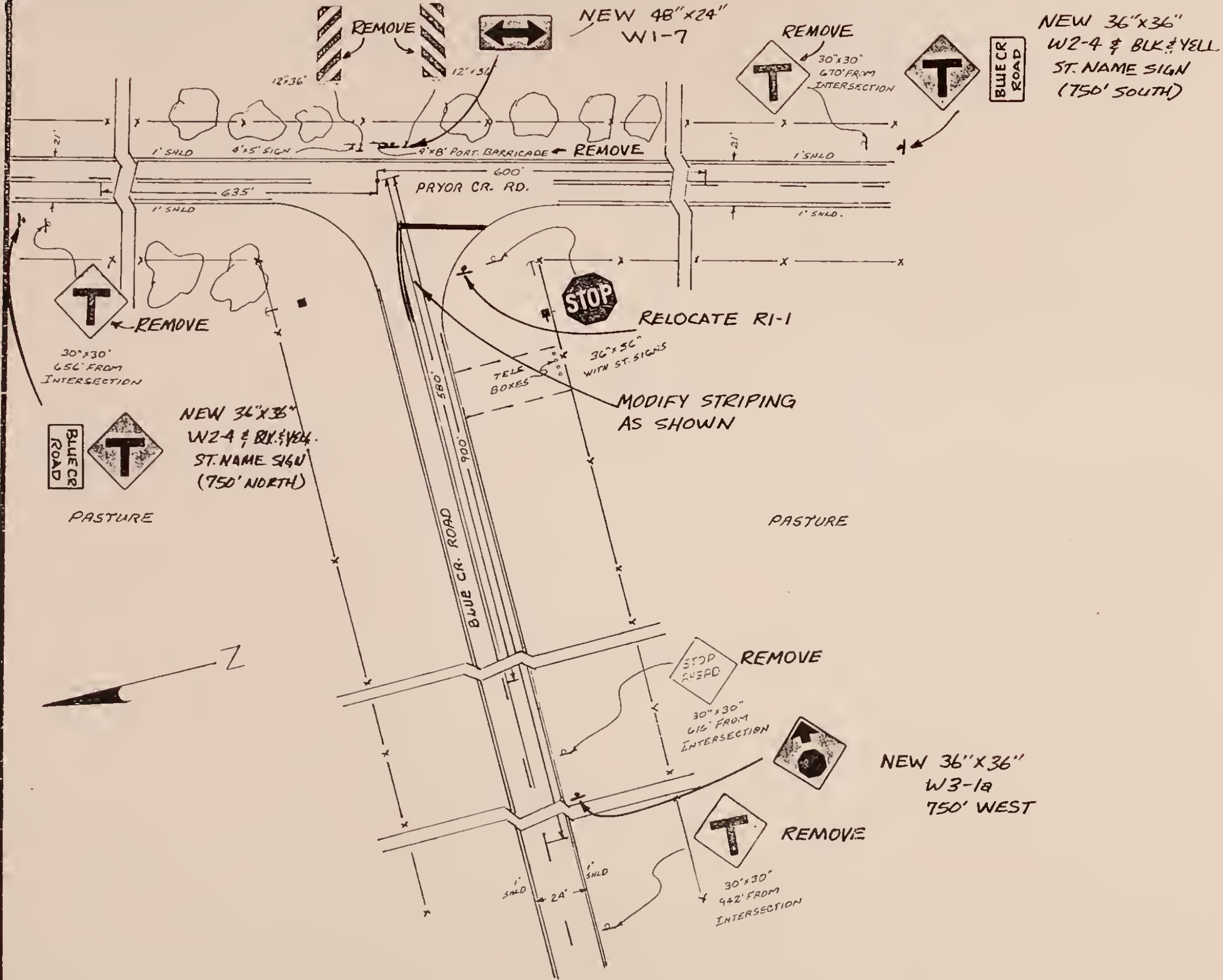


SCALE 1"=50'



ACCIDENT STATISTICS -		BLUE CREEK RD - PRYOR CREEK RD	
ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 = 0		3 DRY = 100%	
1985 = 1		0 WET = 0%	
1986 = 0		0 ICY = 0%	
1987 = 2 TOTAL = 3		LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :		3 DARK = 100%	
0 HEAD ON = 0%		0 DAY = 0%	
0 ANGLE = 0%		SEVERITY - % OF TOTAL :	
0 LEFT TURN = 0%		0 FATAL = 0%	
0 SIDE SWIPE = 0%		2 INJURY = 67%	
0 REAR END = 0%		1 PROP DAM = 33%	
3 SINGLE V = 100%		ALCOHOL INVOLVED	
0 PEDEST. = 0%		2	
0 OTHER = 0%		% TOTAL = 67%	
WEATHER CONDITIONS - % OF TOTAL :			
3 CLEAR = 100%			
0 RAIN = 0%			
0 SNOW = 0%			
0 FOG = 0%			





SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : BLUE CREEK ROAD & PRYOR CREEK ROAD

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	1	35%	0.7	0.4
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	2	1	***	0.7	0.4

% REDUCTION IN INJURY/FATAL ACCIDENTS = 35.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 35.0%

BLUE CREEK ROAD PRYOR ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	\$140.00	\$560.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	\$50.00	\$100.00
4	RELOCATE SIGNS	1	Ea	\$40.00	\$40.00
5	REMOVE SIGNS	7	Ea	\$20.00	\$140.00
6	PAVE. MARKINGS (PAINT)	2	Gal	\$30.00	\$60.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	0	LS	\$1,500.00	\$0.00
10	MISCELLANEOUS	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$900.00

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11

GARDEN AVENUE

PRIORITY NUMBER 11

SITE DESCRIPTION

Garden Avenue is a collector street which is an extension of the I-90 South Frontage Road. It parallels I-90 from Sugar Avenue to the South 27th Street Interchange on the south side of Billings. It serves scattered residential and commercial areas south of the interstate.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. The grade on Garden Avenue is relatively flat, while the horizontal; alignment is a series of sharp curves weaving between residential structures. The paved roadway is very narrow and there are many large trees tall vegetation along the roadside which restricts sight distance.

Traffic Control Devices. Pavement markings at this site consists of a double solid yellow centerline throughout. Signing is composed of advanced curve warning signs, speed limit signs, arrow panels and hazard markers. For the most part, the advanced warning signs are in excellent shape and appear to have been installed within the past two years. These signs have not been installed in the most ideal locations and the advisory speeds are not consistent with the actual safe speed of the curve. Also, 90 degree curve signs are in place where they are not warranted. The existing 90 degree curve is

also the narrowest part of the roadway which makes it very difficult to allow vehicles to meet in the curve area.

Traffic Volumes. Peak hour counts were taken during the morning peak hour. By applying the appropriate factors, it was determined that the average daily traffic is approximately 400 on Garden Avenue.

Traffic Operations. Vehicles using Garden Avenue consist of a large proportion of unfamiliar drivers since this road also serves as an access to a KOA Campground. Speeds along this route do not seem unreasonably high although it is on the high end of the speed limit (25 mph). The roadside environment infringes upon the roadway to an such an extent that motorists are more alert. Accident problems probably affect motorists familiar with the road.

Accidents. There were seven accidents during the four year reporting period. Two were in 1984; one in 1985 and 1987 and three were in 1986. The predominant accident involved the single vehicles. In most cases, the accidents were in clear weather conditions on dry roads. A slight majority of accidents occurred in night time conditions. Injury type accidents were rare at this site.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items, except for curve widening, which consists of sign replacements, new traffic control devices, tree trimming and pavement markings.

The main purpose of these recommendations is to increase the degree of reliable and consistent advanced information which will allow the proper reaction on the part of the motorists. Tree trimming and vegetation removal will improve the severe sight distance restrictions that currently exist.

Curve widening at one location is considered necessary since the roadway geometry and roadside environment allow no forgiveness for any mistakes.

The estimated cost of these improvements is \$6,920.00 based on 1988 unit bid contract prices.

Long term improvements cannot be suggested at this point, since the degree of future traffic growth and the construction of alternate access facilities cannot be predicted with any certainty until some localized development is proposed.

BENEFITS

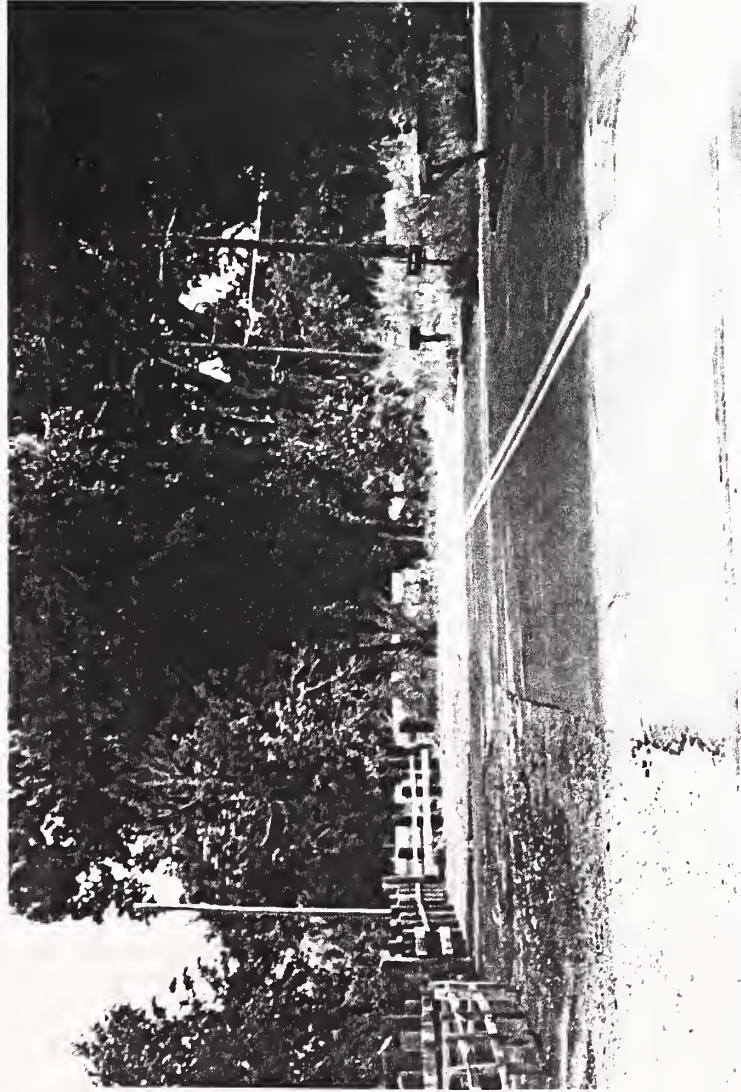
By improving driver expectancy, the single vehicle accident rate is expected to be reduced. The net benefit, according to stated methods, would be approximately \$ 3,426 annually. The cost of improvements compared to the benefit value yields a benefit/cost ratio of 2.79.



GARDEN AVENUE, CURVE 0.2 MILES EAST - EASTBOUND



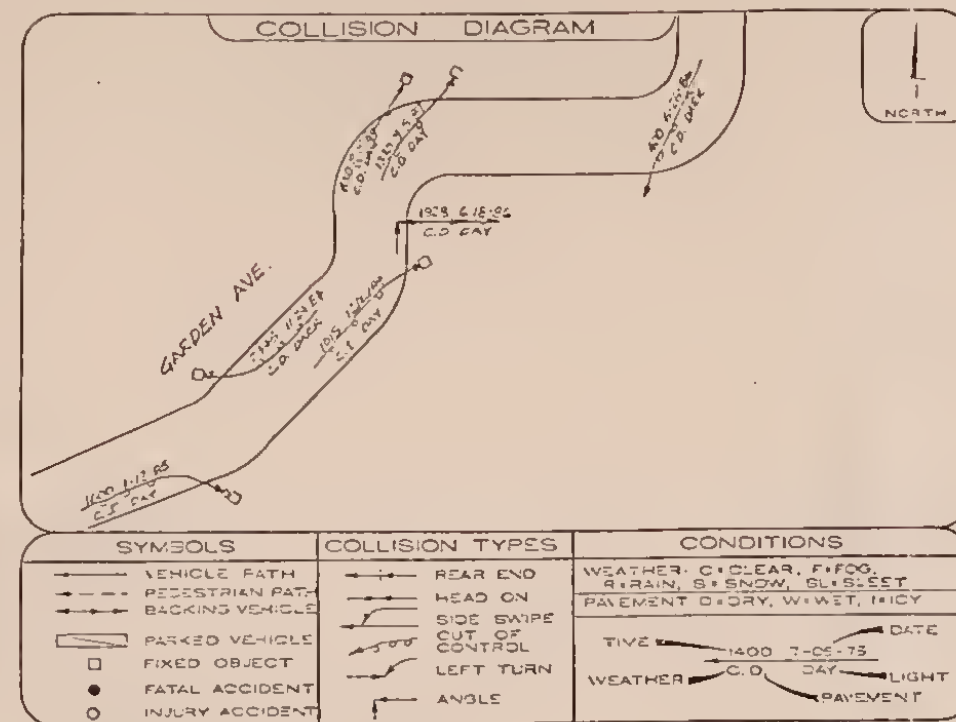
GARDEN AVENUE, CURVE 0.35 MILES EAST - EASTBOUND



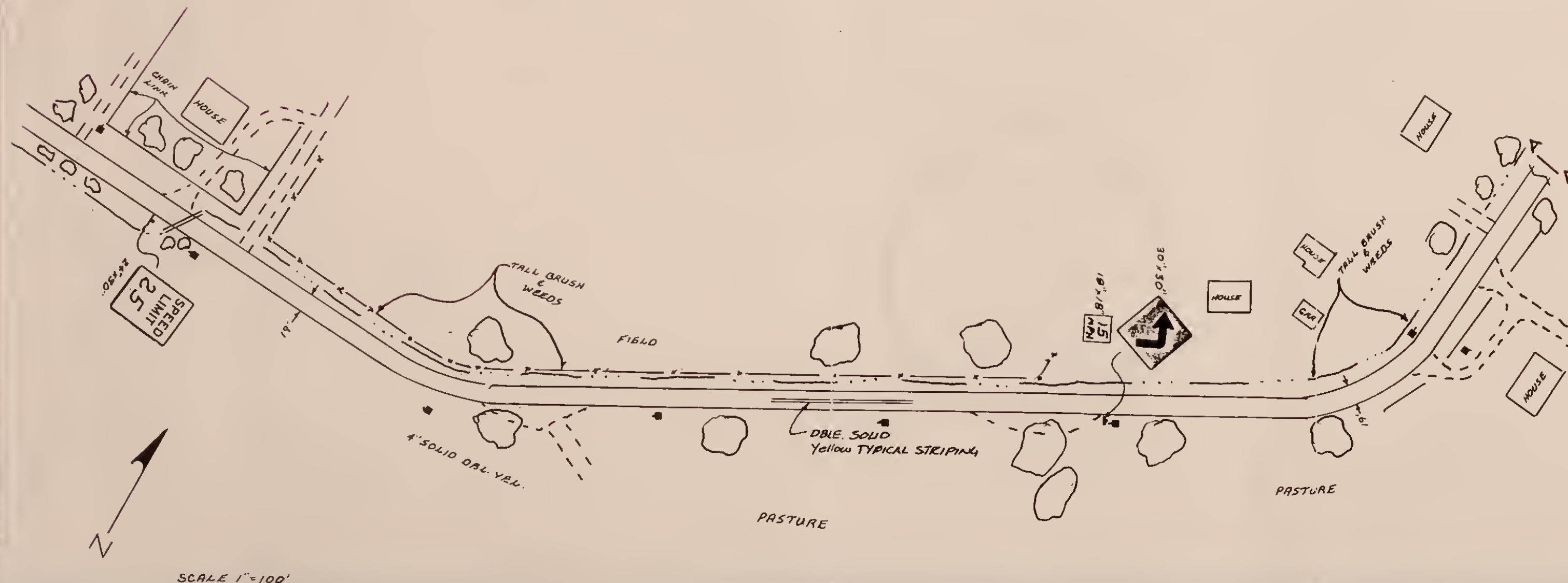
GARDEN AVENUE, CURVE 0.2 MILES EAST - WESTBOUND



GARDEN AVENUE, CURVE 0.35 MILES EAST - WESTBOUND



ACCIDENT STATISTICS - GARDEN AVENUE	
ACCIDENTS / YEAR :	ROAD CONDITIONS - % OF TOTAL :
1984 = 2	5 DRY = 71%
1985 = 1	0 WET = 0%
1986 = 3	2 ICY = 29%
1987 = 1 TOTAL = 7	LIGHT CONDITIONS - % OF TOTAL :
ACCIDENT TYPE - % OF TOTAL :	3 DARK = 43%
0 HEAD ON = 0%	4 DAY = 57%
1 ANGLE = 14%	SEVERITY - % OF TOTAL :
0 LEFT TURN = 0%	0 FATAL = 0%
0 SIDE SWP. = 0%	1 INJURY = 14%
0 REAR END = 0%	6 PROP DAM = 86%
6 SINGLE V = 86%	
0 OTHER = 0%	
WEATHER CONDITIONS - % OF TOTAL :	ALCOHOL INVOLVED 2
7 CLEAR = 100%	% TOTAL = 29%
0 RAIN = 0%	
0 SNOW = 0%	
0 FOG = 0%	



MARVIN & ASSOCIATES

Traffic Transportation & Civil Engineers

SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS, MT 59107
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Project: **TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY**

Sheet Title: **GARDEN AVE. N. OF SUGAR
EXISTING CONDITIONS**

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Revisions
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No. _____
Client No. _____

Sheet No.
1
of **2**

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : GARDEN AVENUE NORTH OF SUGAR AVENUE

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	1	5	40%	0.4	2.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	1	0%	0.0	0.0
TOTALS :	1	6	***	0.4	2.0

% REDUCTION IN INJURY/FATAL ACCIDENTS =

40.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS =

33.3%

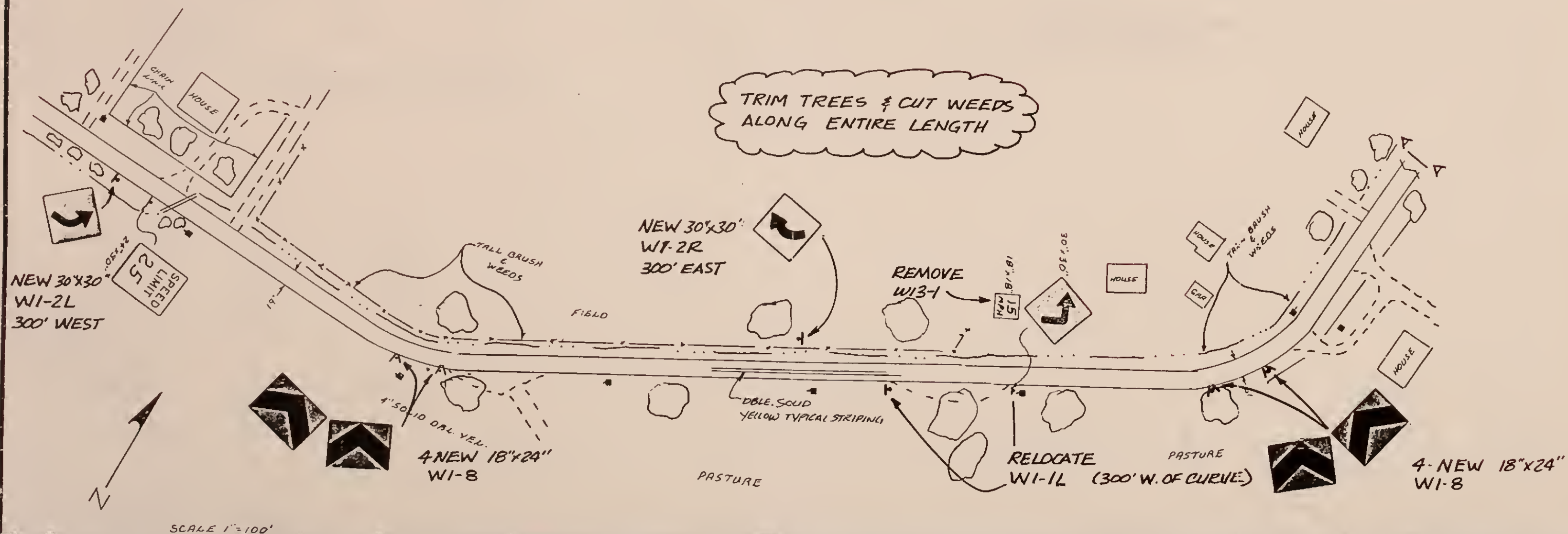
GARDEN AVENUE

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	12	Ea	\$100.00	\$1,200.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	\$140.00	\$560.00
3	NEW SUPPLEMENTARY SIGNS	0	Ea	\$50.00	\$0.00
4	RELOCATE SIGNS	5	Ea	\$40.00	\$200.00
5	REMOVE SIGNS	3	Ea	\$20.00	\$60.00
6	PAVE, MARKINGS (PAINT)	0	Gal	\$30.00	\$0.00
7	PAVE, MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	5	Ea	\$20.00	\$100.00
9	TRIM TREES	1	LS	\$800.00	\$800.00
10	WIDEN CURVE	1	LS	\$4,000.00	\$4,000.00

TOTAL CONSTRUCTION COSTS =

\$6,920.00



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Traffic Transportation & Civil Engineers

Project: TRAFFIC SAFETY STUDY -

YELLOWSTONE COUNTY

Sheet Title: GARDEN AVE. N. OF SUGAR

SHORT TERM IMPROVEMENTS

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Revisions
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No.

Sheet No.

Sheet No.

1
of 2

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12

VALLEY DRIVE - LAUREL

PRIORITY NUMBER 12

SITE DESCRIPTION

Valley Drive is a local, residential type street on the northern boundaries of the Laurel urban area. It begins at 12th Avenue and extends north just over a mile to its northern terminus. It serves as an access road to houses and ranchettes along its length.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. The grades on Valley Drive vary considerably along its length. The most extreme grades are at the crossing of the Big Ditch. A sharp vertical and horizontal curve at this location combine to make it a blind corner. Roadside trees and shrubs also restrict sight distance along its length.

Traffic Control Devices. Pavement markings are non existent at this site. Signing is composed of speed limit signs and hazard markers. For the most part, the roadway and environs have the character of a normal residential street.

Traffic Volumes. Peak hour counts were taken during the evening peak hour. By applying the appropriate factors, it was determined that the average daily traffic is approximately 1,350 near Valley Drive's intersection with 12 th Avenue.

Traffic Operations. Vehicles using Valley Drive consist mainly of drivers familiar with the road and one traffic engineer. Speeds along this street are not unreasonably high. The roadside environment infringes upon the roadway to an such an extent that it is difficult for thru motorists not to adjust speeds for pedestrians; vehicles backing out of driveways; and other activities associated with residential roads.

Accidents. There were five accidents along Valley Drive during the four year reporting period. Two were in 1985 and 1987 and one was in 1984. The predominant accident involved single vehicles hitting fixed objects (mailboxes and bridge ends). In most cases, the accidents were in clear weather conditions on dry roads. All but one of the accidents was in the daytime. Two of the accidents resulted in injuries.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items which consists of sign replacements, new traffic control devices, tree trimming and pavement markings.

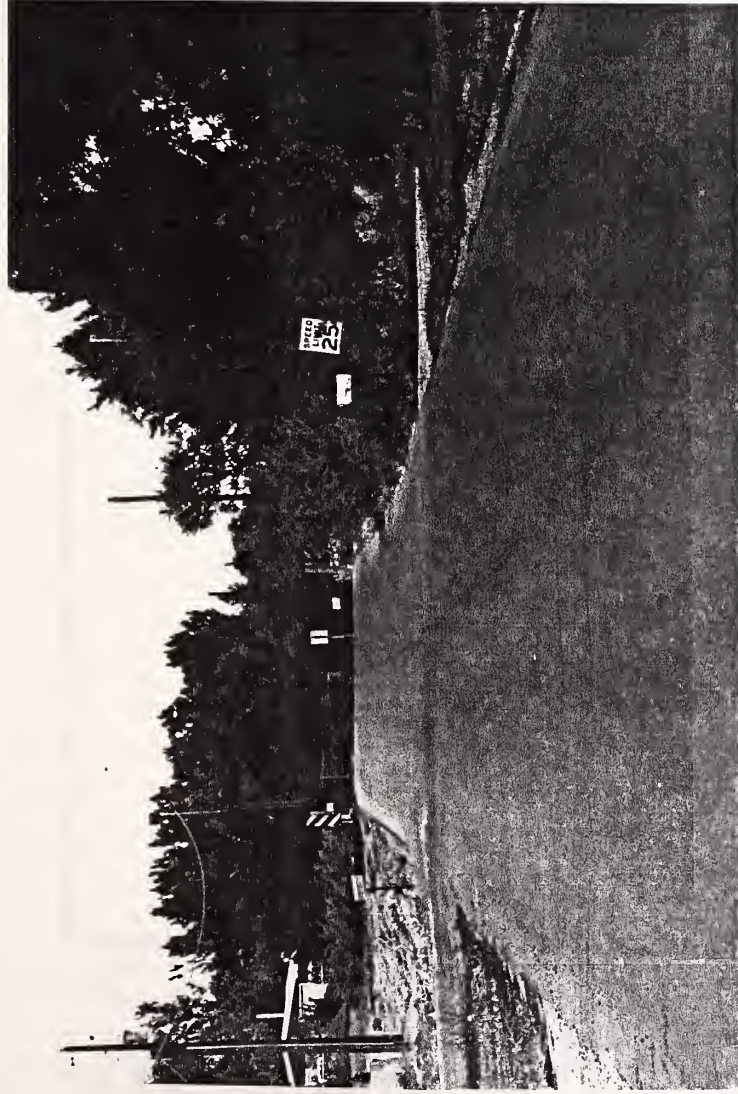
The main purpose of these recommendations is to increase the degree of reliable and consistent advanced information which will allow the proper reaction on the part of the motorists at the locations where conditions are not characteristic of the remainder of the road. Tree trimming and vegetation removal will improve the some of the sight distance restrictions that currently exist.

The estimated cost of these improvements is \$4,260.00 based on 1988 unit bid contract prices.

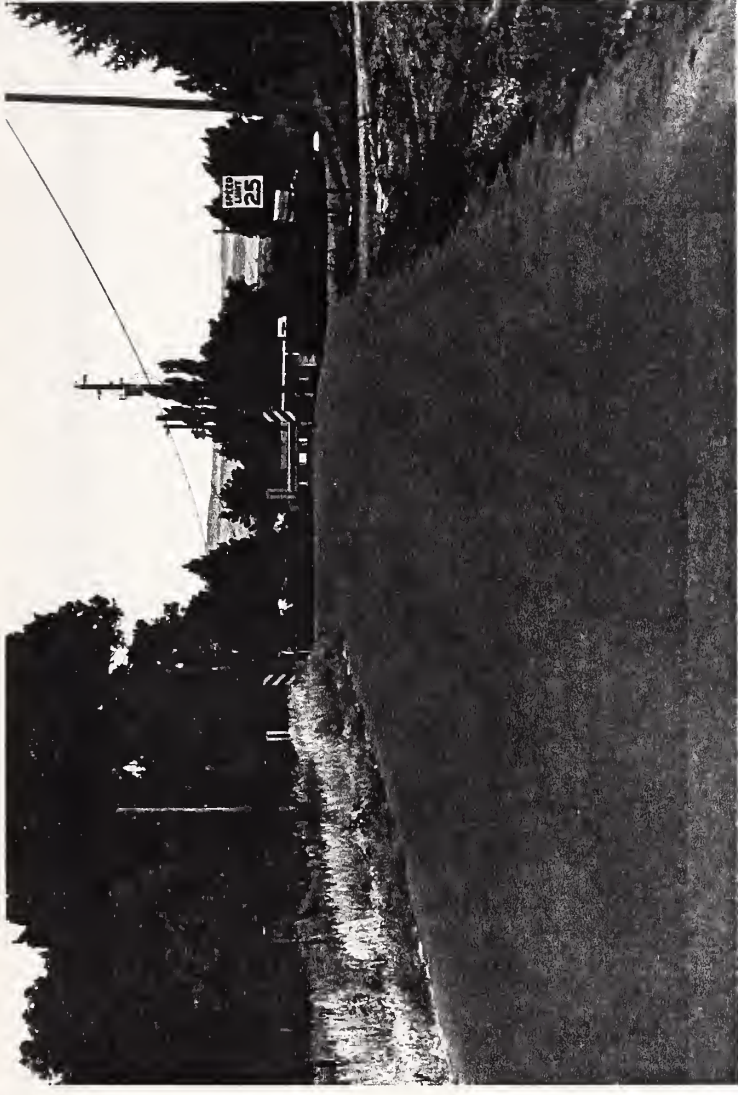
Long term improvements would not be practical at this site.

BENEFITS

By improving driver expectancy, the single vehicle accident rate is expected to be reduced. The net benefit, according to stated methods, would be approximately \$ 4,885 annually. The cost of improvements compared to the benefit value yields a benefit/cost ratio of 2.79.



VALLEY DRIVE 0.4 MILES NORTH - NORTHBOUND



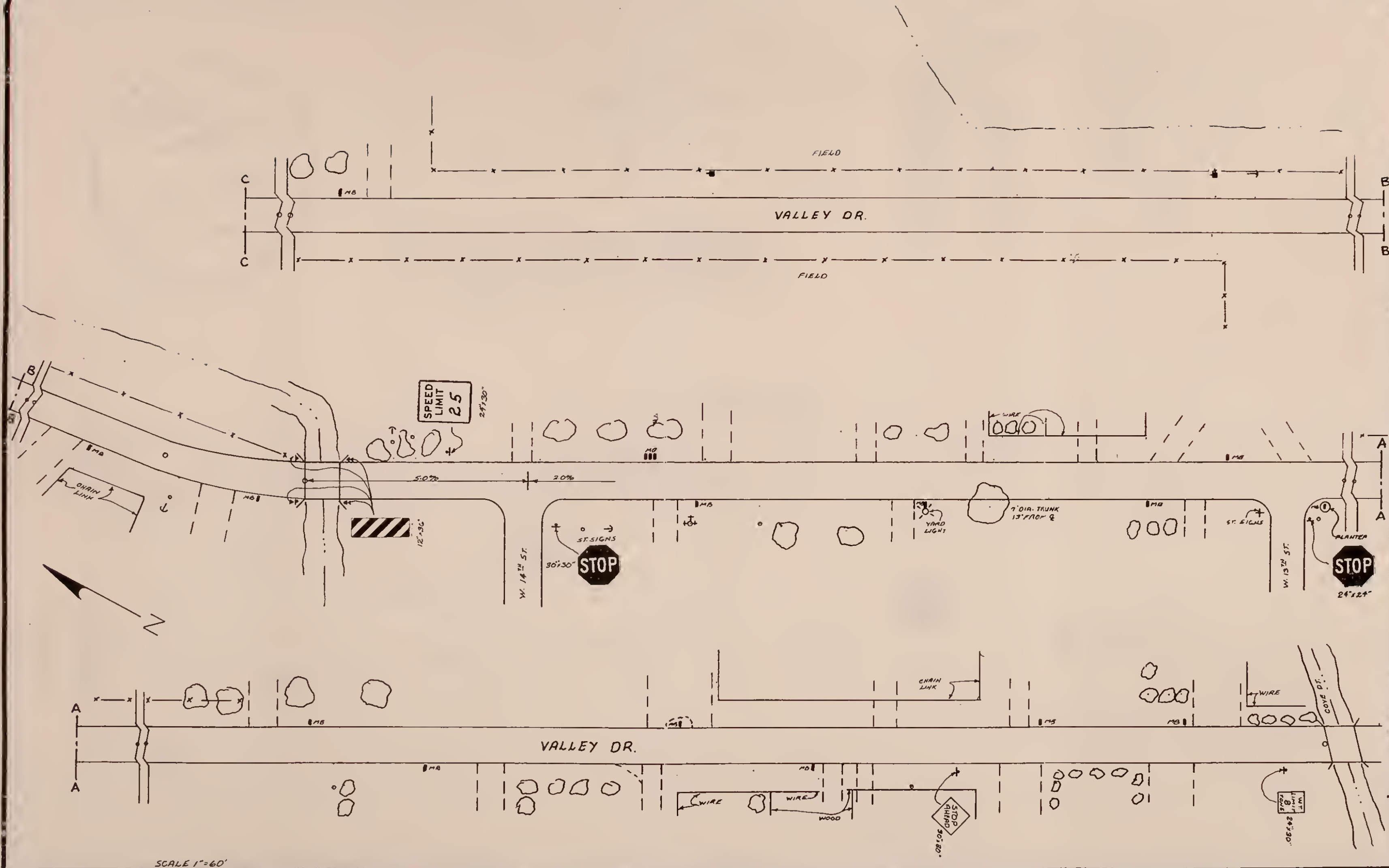
VALLEY DRIVE 0.4 MILES NORTH - SOUTHBOUND



VALLEY DRIVE 0.8 MILES NORTH - NORTHBOUND



VALLEY DRIVE 0.8 MILES NORTH - SOUTHBOUND



SCALE 1"=60'



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Project: **TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY**

Sheet Title: **VALLEY DR. NEAR COVE DR.**

EXISTING CONDITIONS

Surveyed By: _____
Designed By: _____
Drawn By: _____
Checked By: _____
Date: _____

Revisions
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____
No. _____ Date _____

Project No. _____

Client No. _____

Sheet No. _____

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of **2**

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : VALLEY DRIVE IN LAUREL

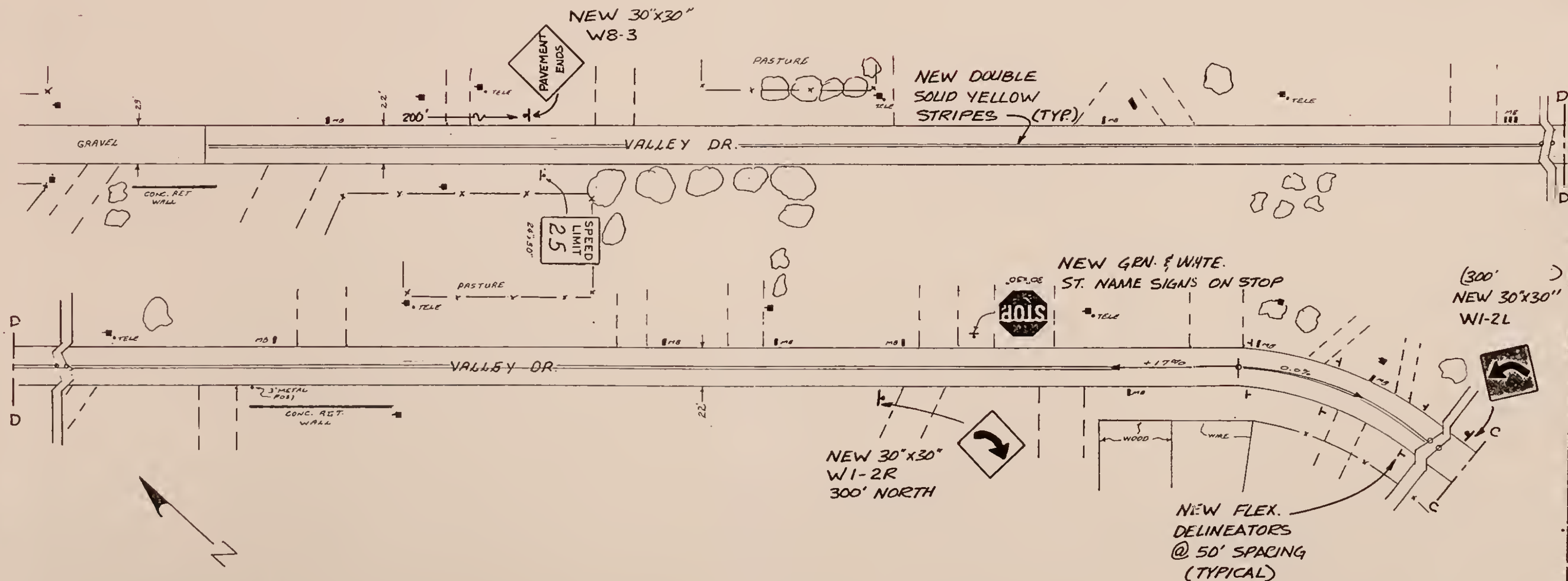
ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PO		I/F	PO
HEAD ON	1	0	50%	0.5	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	0	1	40%	0.0	0.4
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	1	2	20%	0.2	0.4
TOTALS :	2	3	***	0.7	0.8
% REDUCTION IN INJURY/FATAL ACCIDENTS =			35.0%		
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS =			26.7%		

VALLEY DRIVE IN LAUREL

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	1	Ea	\$100.00	\$100.00
2	NEW SIGNS (6.1 TO 10 SF)	8	Ea	\$140.00	\$1,120.00
3	NEW SUPPLEMENTARY SIGNS	6	Ea	\$50.00	\$300.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	1	Ea	\$20.00	\$20.00
6	PAVE. MARKINGS (PAINT)	60	Gal	\$30.00	\$1,800.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	6	Ea	\$20.00	\$120.00
9	TRIM TREES	1	LS	\$800.00	\$800.00
10	WIDEN CURVE	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$4,260.00



SCALE 1"=60'

S I T E

N U M B E R

13

64TH STREET WEST & NEIBAUER ROAD PRIORITY NUMBER 13

SITE DESCRIPTION

Neibauer Road is an east-west arterial which extends from Shilo Road on the east to 80th Street West on the west terminus. Sixty Fourth Street West is a north-south arterial extending from Grand Avenue on the North to a point just north of Interstate 90 on the south. This intersection is located approximately 4.0 miles west of Billings. It is in a rural area with some farm house in the vicinity. Most of the traffic served is rural residential and farm vehicles.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the intersection are less than 2% on all legs. The roadway and roadside environment are typical of the majority of intersections in the farm country west of Billings.

Traffic Control Devices. Pavement markings at this site were striped during the county-wide striping program in 1986. Existing stripes are readily apparent but not consistent with M.U.T.C.D.

No signing other than stop signs with street name signs and advanced warning signs exist at this site.

Traffic Volumes. Peak hour counts were taken during the evening peak (4-5 PM). By applying the appropriate factors, it was determined

that the average daily traffic is approximately 330 on Neibauer and 800 on 64th Street West.

Traffic Operations. It is apparent that the intersection violates driver expectancy and deficient information is provided. The physical features of the intersection are not visible until the vehicle is at the site which leaves no time to react. This deficiency exists for all approaches.

Accidents. There was a total of 3 accidents at this site. One occurred in 1984 and 2 happened in 1985. The predominant accident was the single vehicle accident involving northbound and westbound traffic. The majority of accidents occurred in clear weather and on icy or snowy roads in night time conditions. There was one injury accident at this site.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new stop ahead sign and replacement of the existing stop signs should greatly aid in improving the northbound accident problem. As additional reinforcement, it is recommended that the striping be modified at the intersection.

To improve information deficiencies on 64th Street West, new intersection warning signs with the supplementary name plates should be located 750 feet from the intersection on both approaches. The county should review its maintenance procedures in this area to determine if snow removal efforts are being completed satisfactorily.

The estimated cost of these improvements is \$940.00 based on 1988 unit bid contract prices.

Long term improvements cannot be predicted for this site.

BENEFITS

By improving driver expectancy, the accident rate is expected to be reduced somewhat. The net benefit, according to stated methods, would be approximately \$ 2,199 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 6.32.



64TH STREET WEST & NEIBAUR - NORTHBOUND



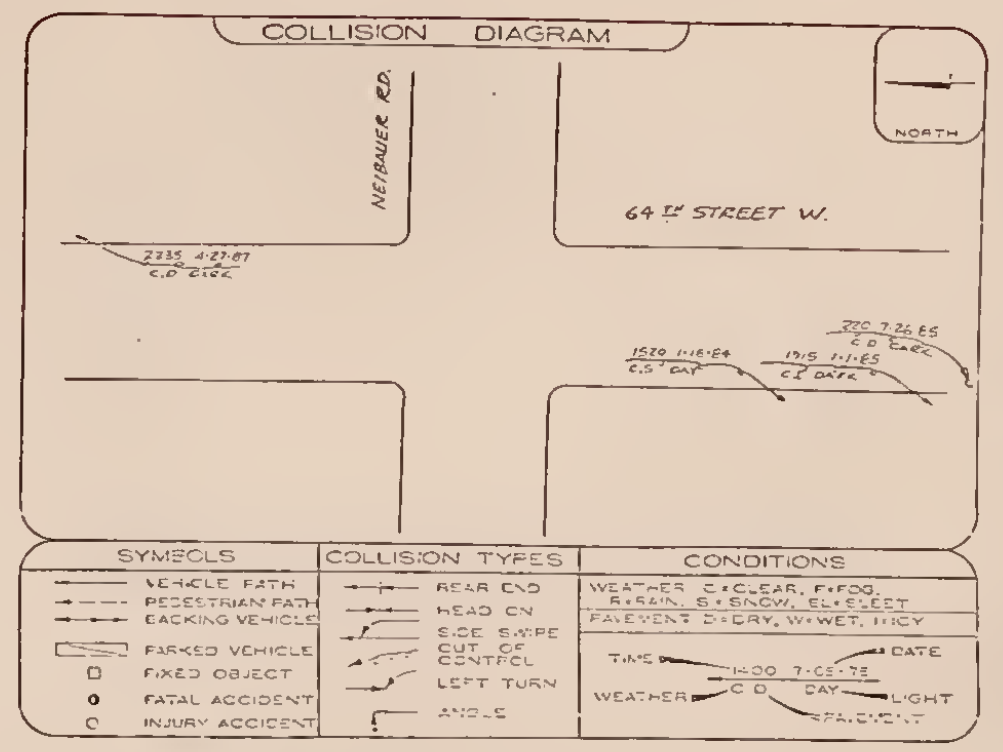
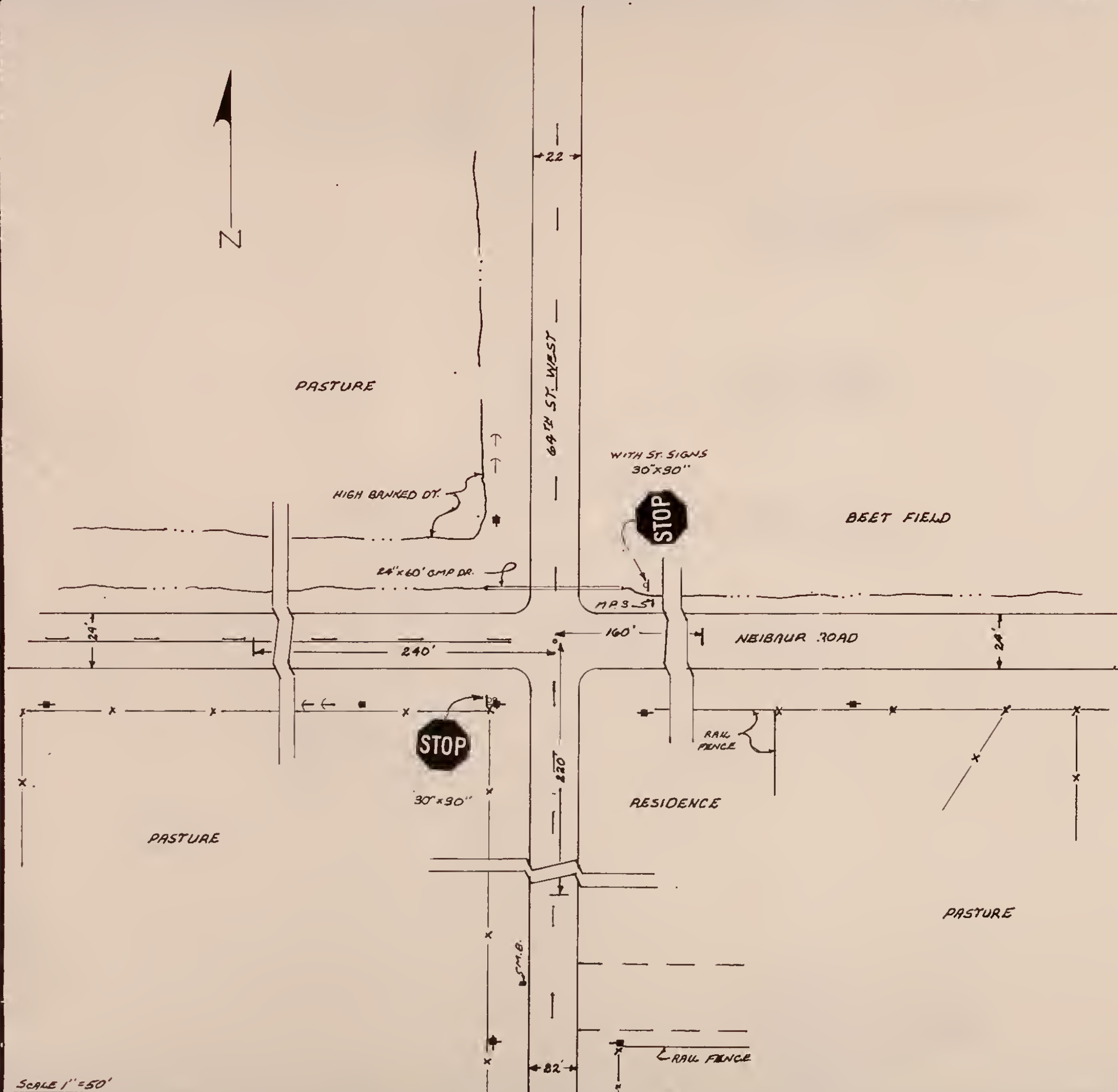
64TH STREET WEST & NEIBAUR - SOUTHBOUND



64TH STREET WEST & NEIBAUR - EASTBOUND

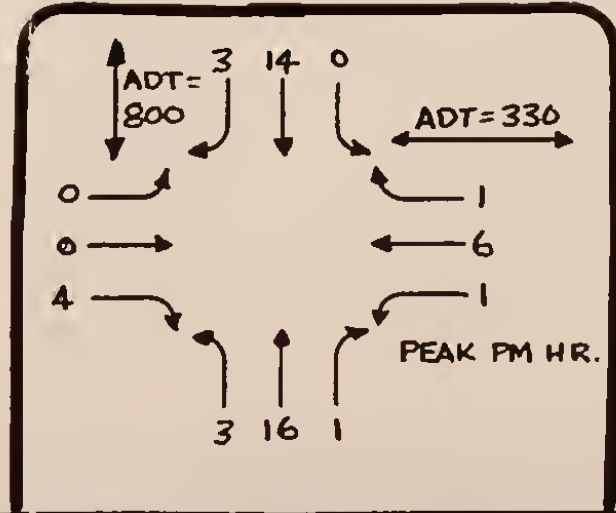


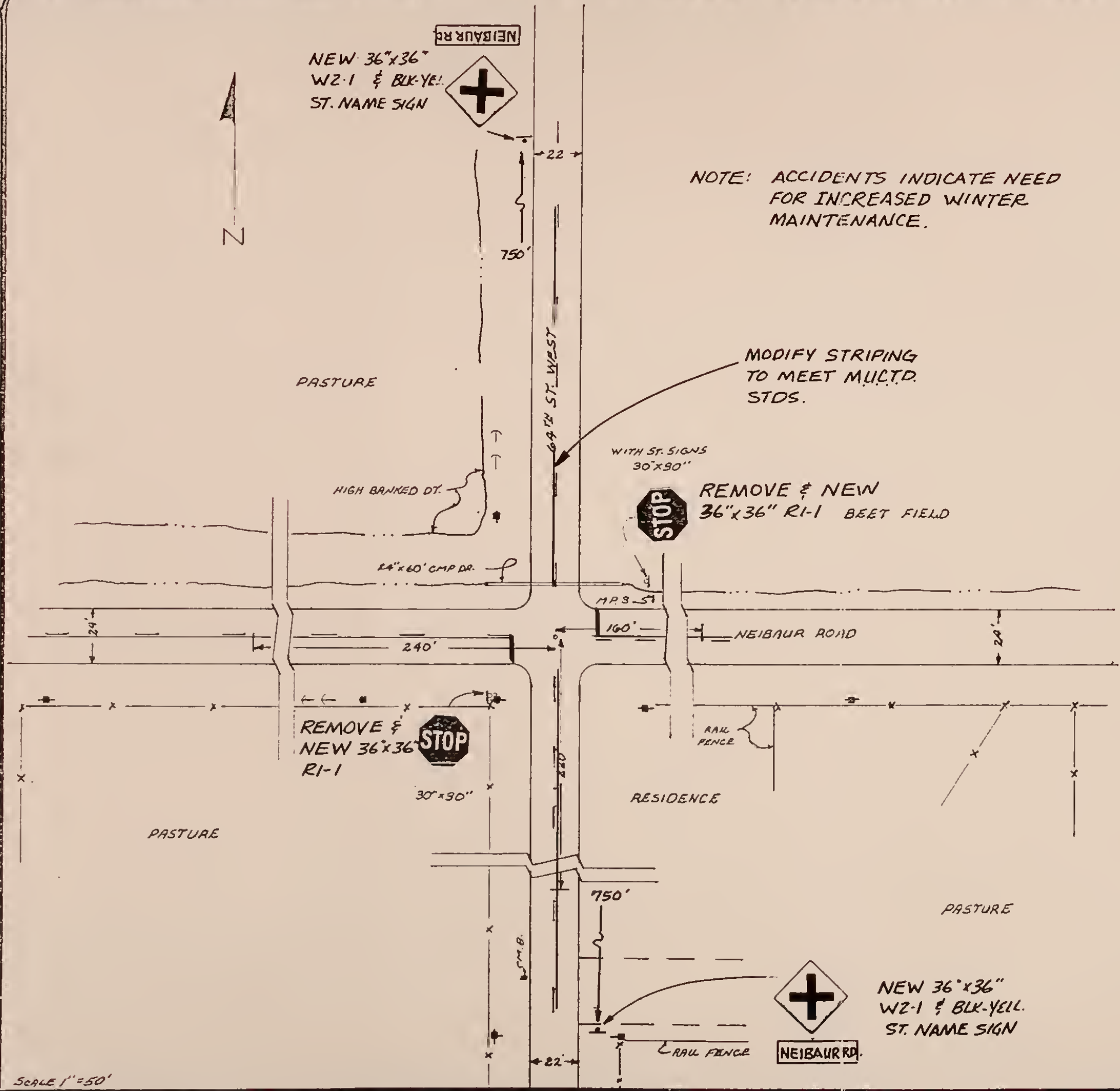
64TH STREET WEST & NEIBAUR - WESTBOUND



ACCIDENT STATISTICS - 64TH STREET W. @ NEIBAUER RD.

ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 = 1		2 DRY = 50%	
1985 = 2		0 WET = 0%	
1986 = 0		2 ICY = 50%	
1987 = 1	TOTAL = 4	LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :		3 DARK = 75%	
0 HEAD ON = 0%		1 DAY = 25%	
0 LEFT TURN = 0%		SEVERITY - % OF TOTAL :	
0 SIDE SWP. = 0%		0 FATAL = 0%	
0 REAR END = 0%		1 INJURY = 25%	
4 SINGLE V = 100%		3 PROP DAM = 75%	
0 PEDEST. = 0%		ALCOHOL INVOLVED	
0 OTHER = 0%		2	
WEATHER CONDITIONS - % OF TOTAL :		% TOTAL = 50%	
4 CLEAR = 100%			
0 RAIN = 0%			
0 SNOW = 0%			
0 FOG = 0%			





SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : NEIBAUR & 64TH STREET WEST

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PD		I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	1	2	30%	0.3	0.6
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	1	2	***	0.3	0.6

% REDUCTION IN INJURY/FATAL ACCIDENTS = 30.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 30.0%

NEIBAUR ROAD & 64TH STREET WEST

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6 SF)	0	Ea	\$100.00	\$0.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	\$140.00	\$560.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	\$50.00	\$100.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	2	Ea	\$20.00	\$40.00
6	PAVE. MARKINGS (PAINT)	8	Gal	\$30.00	\$240.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	0	LS	\$0.00	\$0.00
10	WIDEN CURVE	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS = \$940.00

SCALE 1"=50'

S I T E N U M B E R

14

OLD HARDIN ROAD - CLAYTON

PRIORITY NUMBER 14

SITE DESCRIPTION

Old Hardin Road is a minor arterial which extends from the Lockwood I-90 Interchange at its western terminus to a point near the Pinehills I-90 Interchange at its eastern terminus. It serves as a northern frontage road to I-90 and provides access to a large portion of the urban area known as Lockwood.

Clayton Street is classified as a local street. It is one of several side streets that intersect Old Hardin Road from the south within the accident cluster area. These streets serve residential commercial areas south of the interstate.

The intersection is located approximately 1.3 miles northeast of the Lockwood interchange. The land adjacent to Old Hardin Road for a distance of approximately one mile on each side of the intersection is developed to a relatively high density.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. Clayton Street is skewed approximately 30 degrees off of 90 degrees as are most of the intersecting streets in the area. A lumber company is located in the southeast quadrant of the intersection and a residence is located in the southwest quadrant.

Approach grades along both roads are flat (approximately 1 %). Numerous approaches along Old Hardin Road have filled in ditch sections and positive drainage control is lacking. Large puddles

appear in the intersection area after significant storms because of flat areas in the large area of paving.

Traffic Control Devices. Standard speed signs and stop signs provide the regulatory information at this location.

There is a faint trace of a dashed yellow centerline on Old Hardin Road. There is also traces of double solid yellow, so it is difficult to determine what control the centerline marking is trying to convey. No other markings or delineation were apparent in the intersection area.

Traffic Volumes. Traffic volumes at this intersection were determined by peak hour counts from 4:30 to 5:30 PM. By applying appropriate factors, it was determined that the existing average daily traffic is approximately 2,900 on Old Hardin Road and 300 on Clayton Street. The 1985 study indicated an ADT of 6,800 on this section of Old Hardin Road. This is a decrease of 3,900 ADT since the I-90 Interchange was constructed in 1986 or a 57% decrease.

Traffic Operations. No serious conflicts appear to be occurring within this cluster area. Vehicle speeds appear to be the same or even lower than in 1985 when it was more congested. Sight distance restriction still exists due to the skew of the roadway approach and roadside objects such as trees mailboxes poles and parked cars.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicate that there were six accidents in 1984 and one each in 1985 and 1987. The major accident type was a single vehicle accident. Weather and roads were clear and dry and the majority occur at night. Most of the accidents were property damage only.

It appears that the number of accidents was reduced sharply after the Johnson Lane interchange was built and traffic volumes were drastically reduced. It may be that this site no longer has an accident problem at current traffic volume levels.

SHORT TERM IMPROVEMENTS

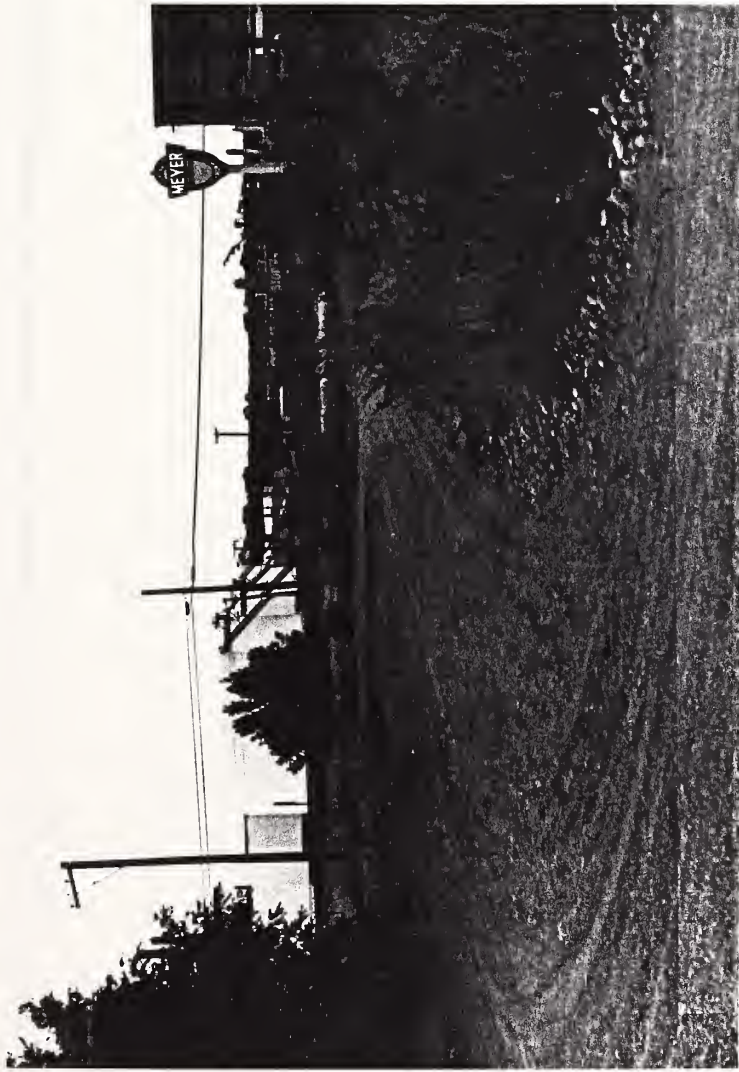
The major improvement suggested at this site is similar to other past recommendations on Old Hardin Road: improve sight distance, increase delineation, improve pavement markings and identify intersecting streets. Other sites within this study suggested a street name plate on advanced warning signs. In this case, a proliferation of warning signs would be required. Therefore, it is recommended that a street name guide sign be installed across from the street approach to aid motorists decision making.

The cost of these improvements is estimated to be approximately \$1,320 based on 1988 unit bid contract prices.

Long term improvements at this site are highly dependant upon the level of traffic volumes that can be expected in the future. If traffic volumes approach pre-1986 levels, reconstruction of Old Hardin Road should be considered.

BENEFITS

The annual dollar benefit that may be realized is computed to be approximately \$2,552. The benefit/cost ratio is computed according to accepted methods at 5.69.



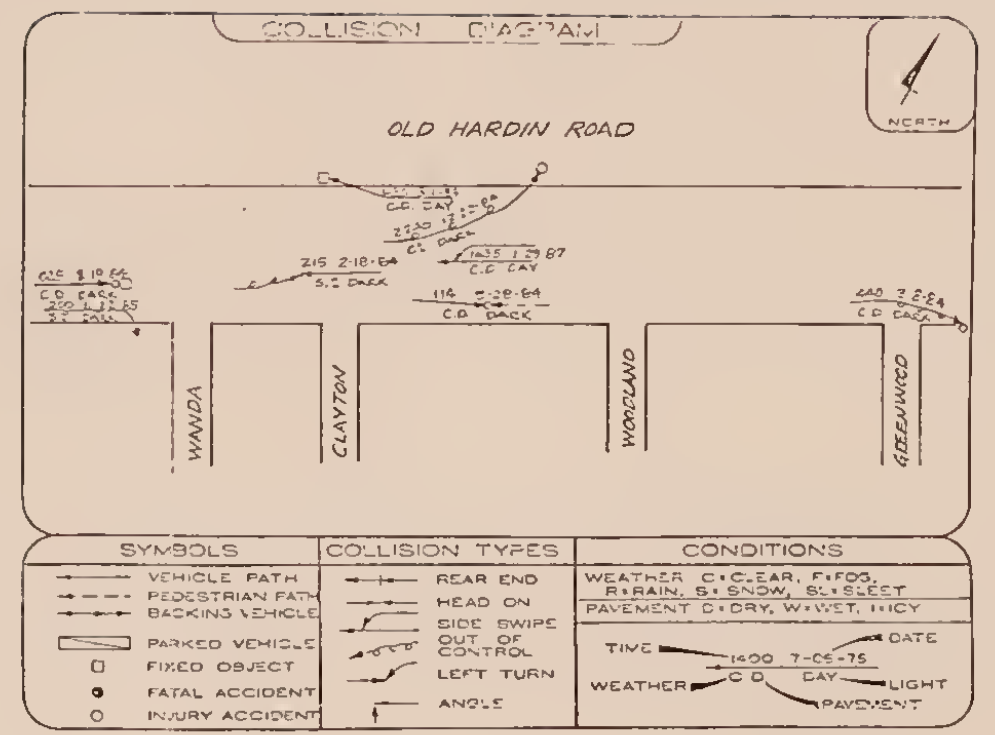
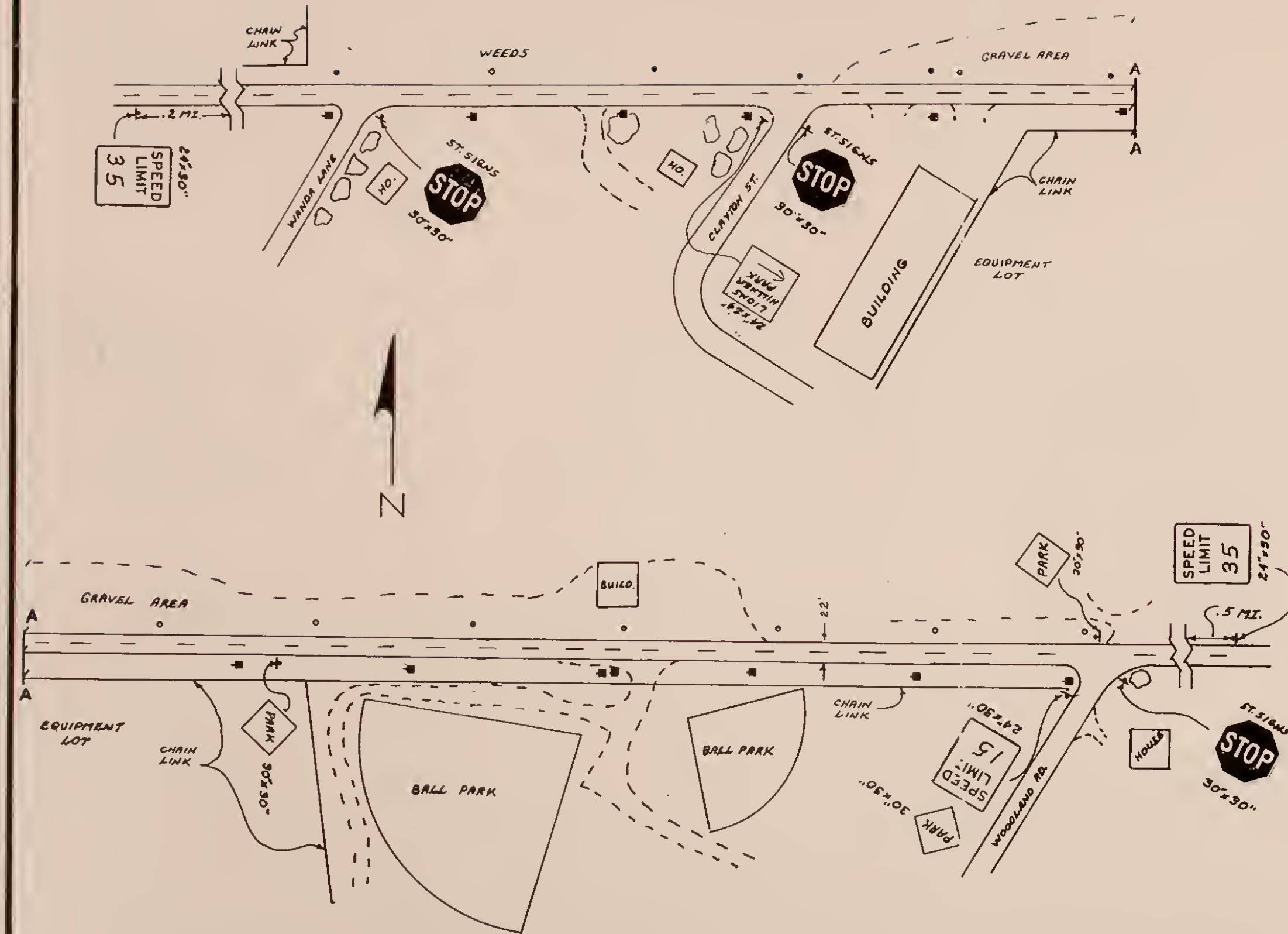
CLAYTON STREET - NORTH BOUND



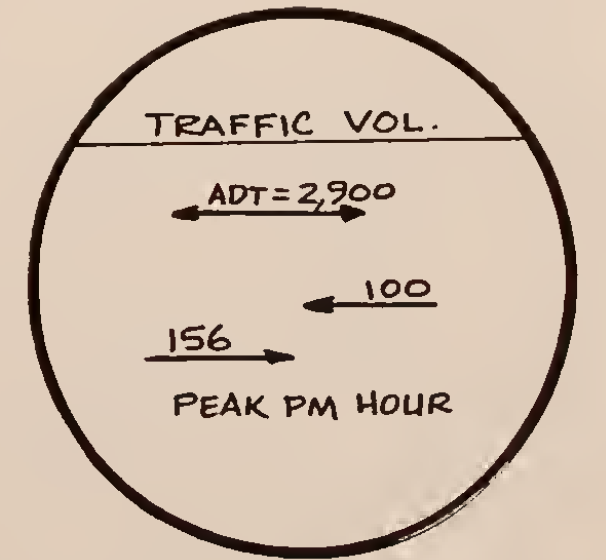
OLD HARDIN ROAD - EASTBOUND



OLD HARDIN ROAD - WEST BOUND



ACCIDENT STATISTICS - OLD HARDIN ROAD	
ACCIDENTS / YEAR :	ROAD CONDITIONS - % OF TOTAL :
1984 = 6	5 DRY = 63%
1985 = 1	0 WET = 0%
1986 = 0	3 ICY = 38%
1987 = 1 TOTAL = 8	LIGHT CONDITIONS - % OF TOTAL :
ACCIDENT TYPE - % OF TOTAL :	6 DARK = 75%
1 HEAD ON = 13%	2 DAY = 25%
0 ANGLE = 0%	SEVERITY - % OF TOTAL :
0 LEFT TURN = 0%	0 FATAL = 0%
1 SIDE SWP. = 13%	3 INJURY = 38%
0 REAR END = 0%	5 PROP DAM = 63%
4 SINGLE V = 50%	
1 PEDEST. = 13%	
1 OTHER = 13%	
WEATHER CONDITIONS - % OF TOTAL :	ALCOHOL INVOLVED 4
6 CLEAR = 75%	% TOTAL = 50%
0 RAIN = 0%	
2 SNOW = 25%	
0 FOG = 0%	



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : OLD HARDIN ROAD - CLAYTON ROAD

ACCIDENT TYPE	# ACC. IN PERIOD		EST. % CHANGE	CHANGE IN # ACC.	
	I/F	PO		I/F	PO
HEAD ON	1	1	10%	0.1	0.1
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	1	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	1	2	20%	0.2	0.4
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	1	0	5%	0.1	0.0
TOTALS :	3	4	***	0.4	0.5

% REDUCTION IN INJURY/FATAL ACCIDENTS = 11.7%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 12.5%

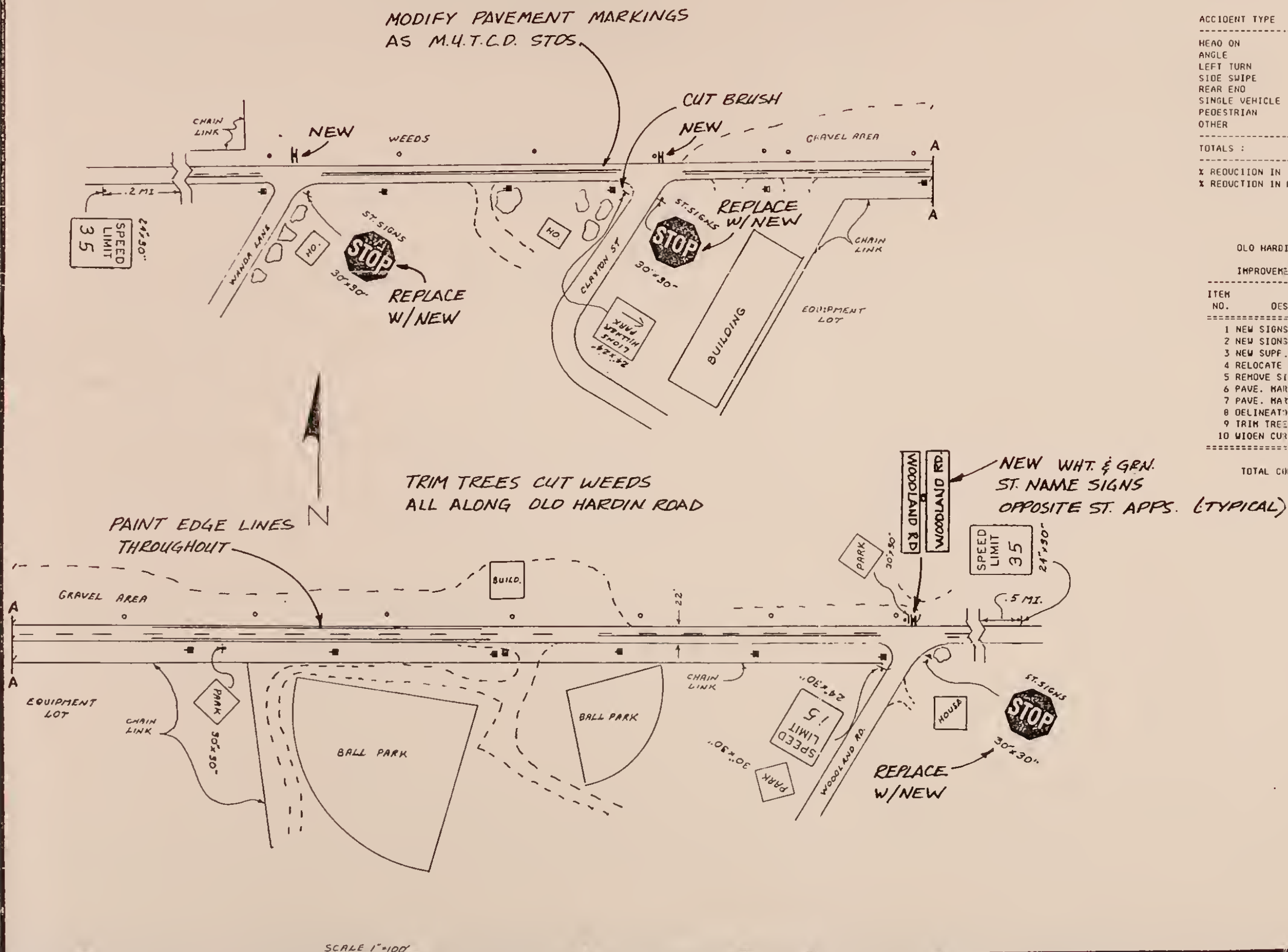
OLD HARDIN ROAD & CLAYTON

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (< 6SF)	6	Ea	\$100.00	\$600.00
2	NEW SIGNS (6.1 TO 10 SF)	0	Ea	\$140.00	\$0.00
3	NEW SUPPLEMENTARY SIGNS	3	Ea	\$50.00	\$150.00
4	RELOCATE SIGNS	0	Ea	\$40.00	\$0.00
5	REMOVE SIGNS	3	Ea	\$20.00	\$60.00
6	PAVE. MARKINGS (PAINT)	17	Sq ft	\$30.00	\$510.00
7	PAVE. MARKING PLASTIC	0	SF	\$6.00	\$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	\$20.00	\$0.00
9	TRIM TREES	0	LS	\$0.00	\$0.00
10	WIDEN CURVE	0	LS	\$0.00	\$0.00

TOTAL CONSTRUCTION COSTS =

\$1,320.00



SCALE 1"=100'



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Traffic Transportation & Civil Engineers

Project : TRAFFIC SAFETY STUDY -
YELLOWSTONE COUNTY

Sheet Title : OLD HARDIN RD. & CLAYTON ST.
SHORT TERM IMPROVEMENTS

Surveyed By :
Designed By :
Drawn By :
Checked By :
Date :

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Client No.

Sheet No.
1
of 1

SITE

NUMBER

15

ROAD 15N - WORDEN

PRIORITY NUMBER 15

SITE DESCRIPTION

Road 15N is one of the major access points from Highway 312 to Worden, Montana. It is a north-south street that extends north from Highway 312 to a point near the Yellowstone River, approximately 2.5 miles north. It serves as a local access street in Worden and it serves farms north of Worden.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. It is a typical urban street. A curb and gutter section runs along most of the west side of the street. Three different street widths are within the cluster area. Near the intersections with Highway 312 it is 27 feet wide; throughout the residential area it is 35 feet wide; and there is a transition down to a 21 foot width on the north section at the beginning of the farm land.

There are open areas of paving on the east side of the road in the school area. This is apparently used for parking and as a drop off area. There are two schools, one on each side of the street.

There are many mature trees lining this street. Low branches tend to obscure signs and side streets.

Traffic Control Devices. There is a moderate degree of signing at this site. It consists mostly of stop signs near the highway

intersection, speed limit signs and school crossing signs. The school and speed related signs are misplaced and totally contrary to the MUTCD.

The only pavement markings in the area are school crosswalks. The crosswalk markings are not very noticeable and they are located in such a manner that they cause undue exposure to children in the roadway.

Traffic Volumes. Peak hour counts were taken during the evening peak. By applying the appropriate factors, it was determined that the average daily traffic is approximately 750 on Road 15N. Side street traffic is negligible.

Traffic Operations. Road 15N has the appearance of a normal residential street. The only difference is that the county road extends miles into the country. Traffic approaching this area from the north may have difficulty reducing speed to residential levels. Also, the existence of adjacent school areas and crosswalks is somewhat unexpected and the lack of proper signing does not help that expectancy.

School was out for summer recess at the time of the observations, so it is difficult to guess what kind of activity occurs with children present. The uncontrolled parking lot access to the street would present some serious conflicts even with very light activity.

Accidents. There were five accidents occurring at this site. Two happened in 1986 and one in each of the other years. Angle accidents were the most predominant. They all occur in clear weather on dry roads, while the majority occurred at night. Most of the accidents involved property damage only. The angle accidents can be directly related to lack of access control.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They consist of signing, pavement markings and curb sections to establish a pattern of access control and to upgrade the school crossings to MUTCD standards.

Stop signs on the side streets will establish Road 15N as the major route and provide control of vehicles for children walking along Road 15N crossing the side streets.

Speed limit signs should never be mounted on the advance school crossing sign. The improvements indicate a separate mounting. Advance schools signs are necessary on each approach to a crossing and school crossing signs are required on each side of each crosswalk.

The crosswalks should be located to maintain the minimum crossing distance of the street. The cross hatched markings are used to increase visibility. Plastic markings are suggested to reduce the need for annual maintenance.

The parking area open to the street should be controlled with pin-down curb to channel traffic and separate the children from vehicles. They also provide an island to place the school crossing sign in a position for maximum visibility.

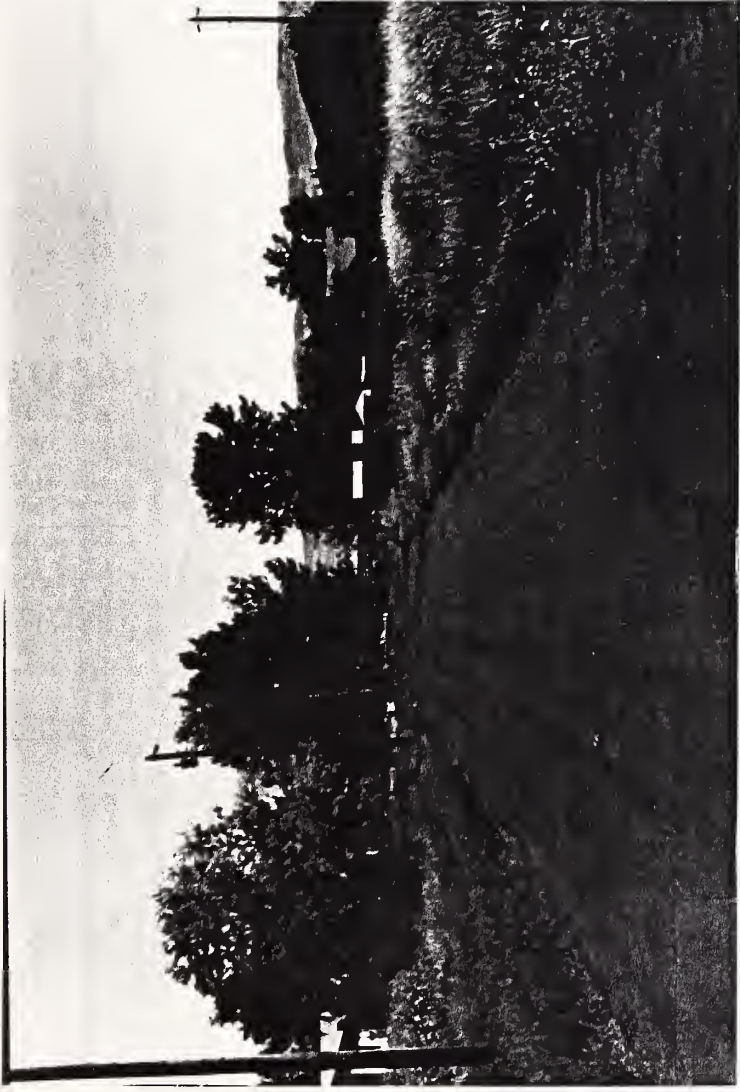
The estimated cost of these improvements is \$5,100.00 based on 1988 unit bid contract prices.

BENEFITS

By improving access control and upgrading the school crossing conditions, the angle accidents are expected to be reduced. Since no pedestrian accidents have occurred, no reduction is possible, yet a single incident prevented would be invaluable. The net benefit, according to stated methods, would be approximately \$ 3,015 annually. The higher cost of improving a potential hazard is included at this site. Reduction in accidents is low and therefore the benefit/cost ratio is only 1.83, lowest of all new study sites. Even so, the potential for tragic accidents with the school crossing should be considered when programming all of these improvements.



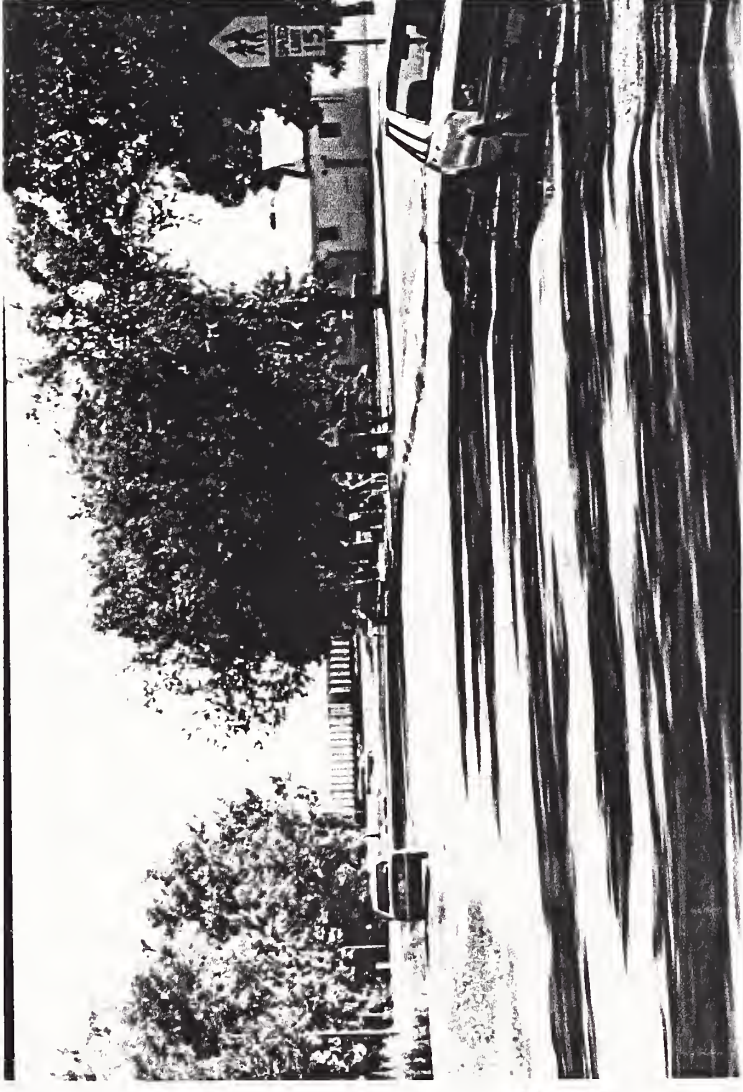
ROAD 15 N - NORTH BOUND



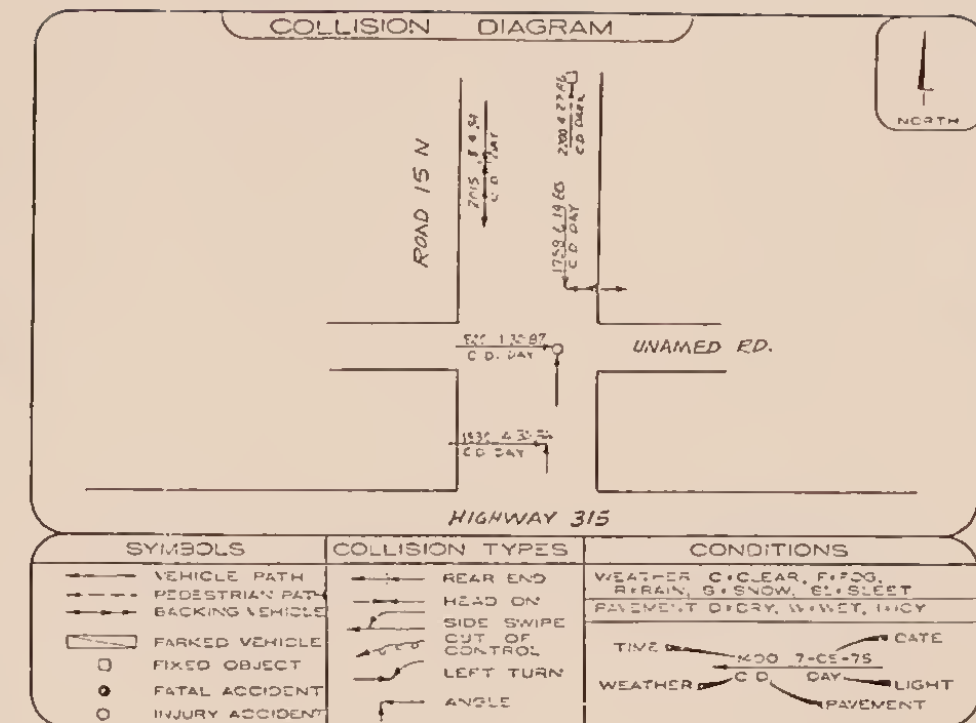
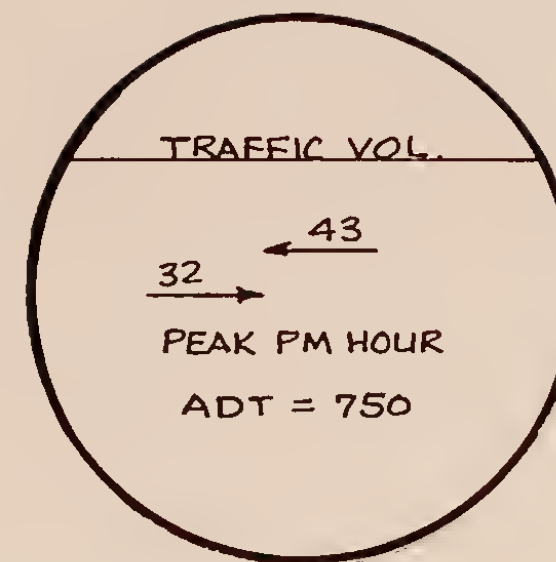
ROAD 15 N - SOUTH BOUND



ROAD 15 N - NORTH BOUND



ROAD 15 N - SOUTH BOUND



ACCIDENT STATISTICS -		ROAD 15 NORTH	
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ACCIDENTS / YEAR :		ROAD CONDITIONS - % OF TOTAL :	
1984 =	1	5 DRY =	100%
1985 =	1	0 WET =	0%
1986 =	2	0 ICY =	0%
1987 =	1 TOTAL = 5	LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :		1 DARK =	20%
0 HEAD ON =	0%	4 DAY =	80%
3 ANGLE =	60%	SEVERITY - % OF TOTAL :	
0 LEFT TURN=	0%	0 FATAL =	0%
0 SIDE SWP.=	0%	1 INJURY =	20%
0 REAR END =	0%	4 PROP DAM=	80%
0 SINGLE V =	0%		
0 PEDEST. =	0%		
2 OTHER =	40%		
WEATHER CONDITIONS - % OF TOTAL :		ALCOHOL	0
5 CLEAR =	100%	INVOLVED	
0 RAIN =	0%	% TOTAL =	0%
0 SNOW =	0%		
0 FOG =	0%		

